THE

ELECTRICAL REVIEW.

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THE

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OVER LEGISLATION AND OVERHEAD WIRES.

IN considering the position of the electrical industry in relation to the legislative enactments which hamper and handicap it, it is interesting to refer to the fact that in 26 British towns the supply of electricity is provided without statutory powers at all; and, moreover, while the question of removing restrictions on the transmission of the current by overhead wires is coming more and more to the front, it is somewhat anomalous to find that in most of the 26 towns referred to, the supply is entirely by overhead mains.

In obtaining the statutory powers conferred by a provisional order, one of the principal objects is to have the right of disturbance of the public thoroughfares for the purpose of laying the mains, and to provide the necessary facilities for having access to them and making the connections with consumers' premises, as, without this power, the public would have a right of action for abatement of any nuisance they could prove and damages for loss sustained by the proceeding.

Notwithstanding all this, we find that in several of the towns we refer to, mains are laid underground as well as overhead, without statutory powers, and apparently without objection on the part of the public.

For example, the Fort William Electric Light Company, Limited, are supplying an area of four miles, and have about 150 consumers, mains laid underground and overhead.

The Chagford and Devon Electric Light Company, Limited, are supplying public and private lighting by a high pressure alternating current system, with two miles of lead-covered paper-insulated cables.

At Larne there are 18 miles of mains, iron-armoured concentric, both underground and overhead, with 2,200 volts at the station, and about 2,000 lamps connected.

At Lynton and Lynmouth, the high pressure current is transmitted by Callender's lead-covered cables in casing, and rubber cables in pipes, and about 3,000 lamps are connected belonging to 64 customers.

Macroom and district is supplied with an alternating current of 2,200 volts transformed to 230, and the cables are lead-covered and armoured, in bitumenised wood troughs; about 100 customers are supplied.

These are instances of underground mains being employed with all the necessary disturbance of the streets, and without statutory powers; the several companies proving by their action that so far as public interference is concerned, there is not much to fear.

Another, and perhaps a much more important matter, is the evidence afforded in the 26 towns in question, of the absence of danger from overhead wires, even in urban districts.

Take the case of Hampstead, where a supply, commenced in 1892, is being given through 38 miles of mains, all overhead.

At Northallerton, 5 miles of bare conductors are carried on steel poles 21 ft. high.

At Buckingham, all the feeders and distributing mains are carried overhead.

At Carlow, overhead wires have transmitted current at 2,500 volts since 1892.

The question of overhead transmission of electrical energy over long distances is of vital importance, if all the advantages are to be secured for the public, for which the several power schemes have recently been sanctioned by Parliament.

Two reasons are commonly given against the system; in the first place, the possible danger, and secondly, the æsthetic objection. The first is readily met by reference to the practice in America, Germany and Switzerland, where the long-distance transmission is always by overhead mains, and instances of accidents of any kind are extremely rare.

The overhead mains adopted in the 26 towns in this country, working without statutory powers, some of them for a period of 10 years and upwards, may be cited as a proof that even in London and other towns less danger has been experienced than in some underground systems where accumulations of gas from defective gas mains have done considerable mischief.

But there can be no valid objection to overhead wires in rural districts, where long stretches of agricultural land must be crossed between the towns and villages, through valleys and over hills, where the laying of underground mains would involve an enormous outlay.

We have become so accustomed to the telegraph poles all over the country that an addition to their number would hardly excite remark, and would certainly be less unsightly or suggestive than the ubiquitous and obtrusive invitations to patronise liver pills and lung tonics.

The wayleaves paid to the landlords and tenants for the few inches of ground occupied by the poles doubtless would be considered a boon by our distressed agriculturists, apart from the facility afforded for obtaining electricity in out-of-the-way places, and even for farming purposes.

The report by the Electrical Power Mains Regulations Committee appointed by the Electrical Section of the London Chamber of Commerce in February last is a most valuable contribution to the question of long-distance transmission of electrical energy at extra high pressure. The Committee advocate the employment of bare wire overhead transmissions in suitable rural districts, and to enable this to be done, suggest alterations in the Board of Trade regulations which have hitherto rendered it impracticable.

The Committee point out that large districts in this country over which Power Supply Acts have been passed are of similar character to areas on the Continent and in America, where bare overhead wires have been successfully and safely used at very high voltages for the past 10 years; and they suggest that the existing regulations should be brought into line with those current in other countries.

The conclusions of the Committee are so obviously sound, and the interests of the electrical industry are involved to so serious an extent, that every effort must be made to overcome the opposing forces which have so long prevented this important business from being properly and rapidly developed in this country.

It would be more consistent with a patriotic spirit if Parliament and our local authorities fostered so important an industry as electric supply, instead of hampering it with laws and regulations which compare most unfavourably with the procedure in Switzerland, Germany, France and the United States, so ably compiled by Mr. E. G. Cruise for the Committee whose report we have referred to.

President McKinley.

THIS morning most of us are giving thought to the final ceremonial in the obsequies of the sadly lamented President of the United States. The heat of our infuriated rage at the assassin who committed this foul act subsided, perhaps, as the hope of recovery grew stronger and yet stronger, but when those hopes were dashed aside, the terrible disappointment created by the reception of the sad news fanned the smouldering embers to a sudden flame of sevenfold fierceness. To a man, the old country joined hands with the new, and the self-respecting Anglo-Saxon race was unanimous in its indignation at that parasitic section which madly, and with repugnant cowardice, glories in robbing nations of their greatest and their best. The spirit of the avenger is still abroad in the land, but soberer moments possess a milder wrath. The people of the United States have lost their own elected ruler, and Britain but yesterday lost her well-beloved and Royal Queen. These two events have served to knit two peoples of the self-same race still closer together, and the mutual expression of manifold sympathies will conduce to the production of a greater spirit of brotherly kindness than ever before.

It may appear to some that we, as the editors of a technical journal, are passing without the limits of our customary province in mentioning such a matter in our columns. In justification, if need be, we raise the plea that the electrical professions and industries of the two worlds are so inseparably inter-connected, and there is so cordial a fraternising spirit evident whenever American electrician meets British, that it is but right to allow our columns to voice the heart-felt sympathies which electrical engineers in Britain and her Colonies beyond the seas have for their American *confrères* in their national calamity so recently sustained.

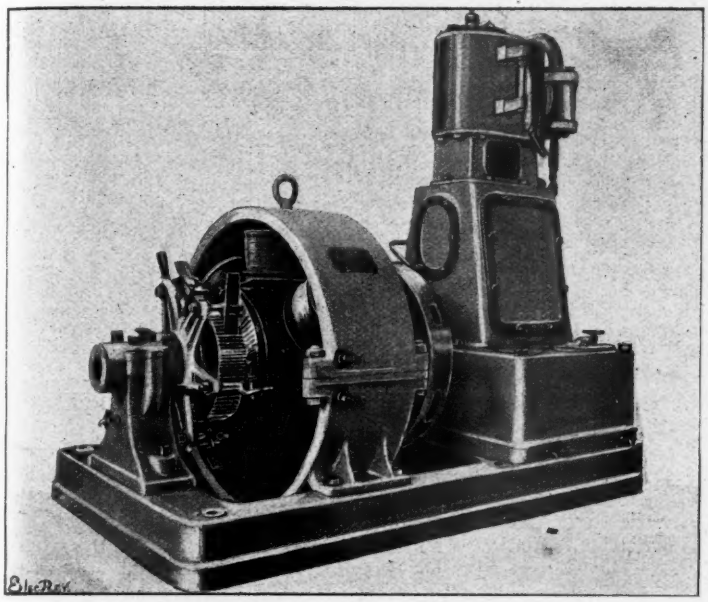
The Manufacture of Pure Alumina.—Mr. C. M. Hall, of Niagara Falls, has patented (No. 14,572, August 14th, 1900) an electrical process for winning pure alumina from bauxite. The mineral is mixed with a small quantity of carbon and calcined, and then more carbon is added to bring the total proportion up to 8 or 10 per cent. If the ore is poor in iron, some ferric oxide is introduced, and in certain cases a flux, *e.g.*, fluorspar, lime, cryolite, or soda is added. With or without these ingredients, the mixture of calcined bauxite and carbon is incorporated with a certain proportion of aluminium powder for the purpose indicated below, the proportion of metal being regulated to suit the percentage of ferric oxide, silica, and titanic acid occurring in the original bauxite; and the whole is fused at an elevated temperature, or for a considerable time in an electric furnace. The added aluminium combines with the iron, silicon, and titanium of the mineral to form an alloy which sinks to the bottom of the bath, and is subsequently removed through a tapping hole. The material remaining in the furnace is pure alumina free from sodium; it is allowed to cool, reduced to powder, freed from metallic particles by magnetic treatment, and finally converted into metallic aluminium by the regular electrolytic method at present employed.

GLASGOW INTERNATIONAL EXHIBITION, 1901.

X.

The Sunderland Forge and Engineering Company, Limited.

This firm shows two ship-lighting plants, an enclosed ventilated motor, and an electric winch. One engine is of



Closed Type Engine and "Pallion" Dynamo.

their open type, and direct coupled to one of their "Pallion" multipolar open type continuous current compound wound dynamos. This set is capable of an output of 65 amperes at 100 volts when running at 350 revolutions per minute, and with 80 lbs. of steam at the engine stop valve. The governor is of their special throttling type, and controls the speed of the engine within 2 per cent. from no load to full load. The load can also be varied to any extent without necessitating any moving of the brushes.

The enclosed type of engine shown by this firm possesses the same type of governor as that mentioned above, and, in addition, is provided with a pump for lubricating the different parts of the engine under pressure. This engine is also coupled to a "Pallion" multipolar generator, having an output of 99 amperes at 100 volts when running at a speed of 550 revolutions per minute, with 80 lbs. of steam at the engine stop valve.

The "Pallion" motor exhibited on this stand is of the firm's latest design, in which special attention has been paid to the accessibility of the various parts, to ventilation, and to obtaining fixed brushes. The motor shown is capable of developing 10 B.H.P. when running at about 650 revolutions per minute on a 100-volt circuit.

The electric winch embodies the novel principle of revolving both field magnets and armature. When working normally the armature is held by an electric brake and the field magnets revolve, but should the load on the barrel exceed a predetermined amount, the electric brake is arranged to slip and allow the barrel to stand while the armature revolves. It will be seen that this arrangement immediately takes up any slack in the rope, and avoids all risk of burning out or blowing a fuse if the load jams. This winch was specially designed for wharfage use.

There is also a collection of photographs showing, amongst others, an 80-KW. two-pole dynamo coupled direct to a central valve engine, five 400-H.P. tramway and lighting sets coupled to Belliss engines, a portable winch suitable for use in shipyards, one of the firm's multipolar open type generators for belt driving, and a two-pole generator for belt driving.

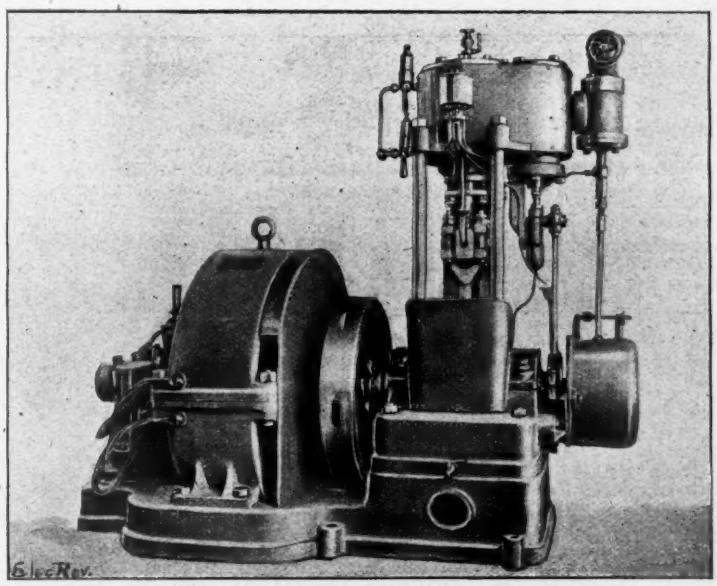
This firm supplied the motor for running the wood-working machinery at Messrs. John McDowall and Sons' stand, where there is also to be seen running a portable electric saw bench suitable for shipyard work, which we illustrate.

The Edwards Air Pump Syndicate, Limited.

The exhibit of the Edwards Air Pump Syndicate consists of a set of three-throw air pumps of the Edwards patent type, driven by a Lundell motor, the whole forming a compact arrangement, as shown in the illustration on p. 460.

These pumps are now being largely adopted for electric lighting and traction stations, as, owing to the special construction of the Edwards pump, it is admirably adapted for running at high speeds, and is consequently very suitable for being driven by means of electric motors. In many cases the motor has been direct coupled to the pump crankshaft, but the pumps exhibited are driven by a high speed motor, and the necessary speed reduction is effected by means of a Hans Renold chain.

In the Edwards pump, as will be seen by reference to the sectional illustration, foot and bucket valves are entirely dispensed with. The only valves used are those which in the old type of pump are known as the "head" valves, and these are readily accessible by removing the door at the top of the pump. Thus one of the principal causes of breakdown and delay, viz., the giving way of inaccessible valves, is



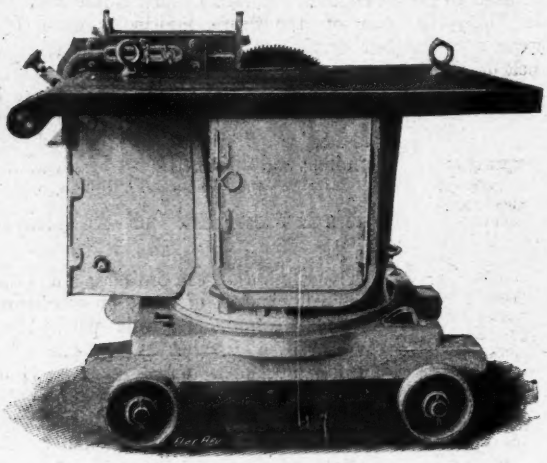
Open Type Engine and "Pallion" Dynamo.

entirely removed, and as there is but one set of valves to renew instead of three sets, a considerable saving is effected in maintenance charges and the time necessary for overhauling.

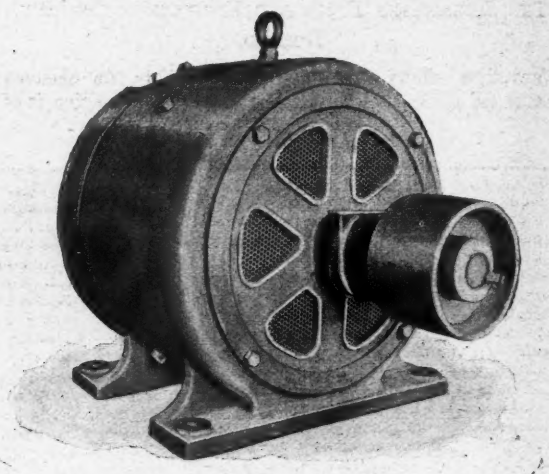
Another important feature in the Edwards air pump is that the water is dealt with mechanically, and as come-

quently the speed of the water must correspond to the speed of the bucket, a regular quantity of water is assured for each revolution of the pump, and the sudden flooding which frequently takes place when the old type of pump is run a high speeds is avoided. The efficiency of the pump is also increased by the provision of clear air inlets and by the reduction of the top clearance to a minimum.

We understand that the Edwards pump has been employed in many of the leading electrical installations, including those of the City of London, Glasgow, Liverpool, Manchester, Salford and Newcastle-on-Tyne, besides over 80 other important Corporations and companies.



Glasgow Exhibition: Portable Electric Saw-Bench.



Glasgow Exhibition: "Pallion" Enclosed Motor.

MUNICIPAL TRADING.

(*Concluded from page* 379.)

The editor of the *Municipal Journal* comes forward in defence of municipal trading, and starts by quarrelling with the term. He does not consider it as a trading business if a corporation supplies the common needs of the community, in which he includes gas, electric light, and tramways; but where it exists he considers it simply incidental to, and inseparable from, public works under municipal management.

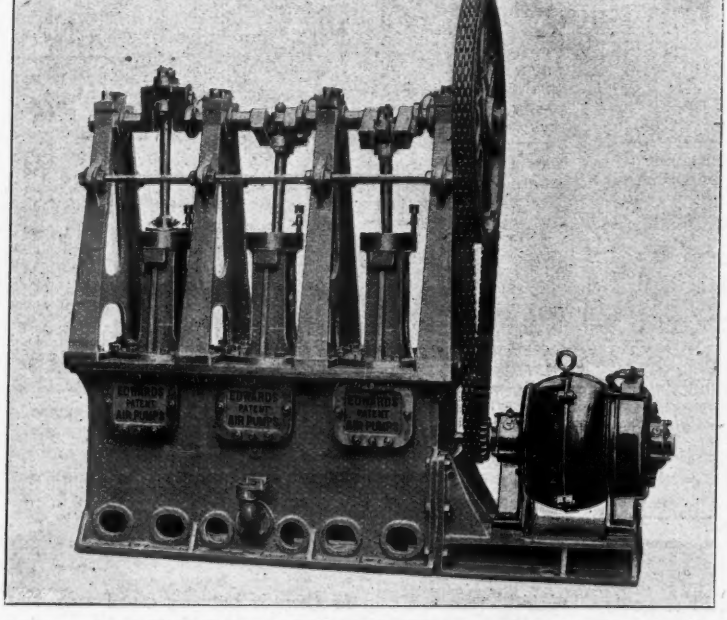
This sophistical reasoning prepares one for the generally fallacious arguments which run through his paper.

He assumes that the local authority should supply the common needs of the community, and asserts that the electric light is one of them—but we dispute both propositions.

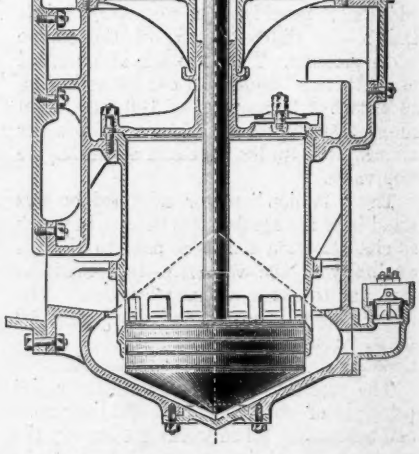
If the common needs are to be supplied by the municipality, the limit of the trading must be extended to the definition given in the question of the Earl of Wemyss to Mr. John Burns during the discussion of Mr. Dixon H. Davies's paper on "The Cost of Municipal Enterprise." He asked Mr. Burns "Whether it is not his view that private trading should be abolished, and that all land, capital, and instruments of production and of trading should be in the hands of a labour-governed State? Is that not so?" and Mr. Burns replied in one word, "Yes."

Here we have the straightforward demand of the municipal Socialist, and the only logical outcome of the system, which the editor of the *Municipal Journal* advocates in a more timid way.

If the common needs of the community are to be supplied, why talk of electric light and tramways? Surely provisions, clothing, shelter, and suitable occupations come



Glasgow Exhibition: Edwards Three-throw Air Pump driven by Lundell Motor.



Glasgow Exhibition: Section of Edwards Air Pump.

before all, and Government must become the universal provider, all private enterprise in trade being abolished.

The writer's belief is that there has been very little genuine public opinion behind the agitation against municipal trading, and so far as the general apathy on the part of the public with respect to most questions is concerned, he is right, but where is there any intelligent, well-informed public opinion in favour of municipal trading?

If some local authority appealed to the ratepayers to support them in abolishing private trading, with a view to their opening a general stores for supplying all the necessities of the community, how many traders would support them? but until the general interests of the shopkeepers are affected, they will probably be to a certain extent indifferent as to who supplies electricity, especially when they feel no pressing need for it themselves.

When appealed to on the subject of a municipal speculation, with the risk of an increase in the rates, sufficient interest is aroused to defeat the projects of the socialist party on the Town Councils; but too often the mischief is done before the ratepayers know anything about it.

Local authorities, as a rule, are elected by a small minority of the ratepayers, especially in the large towns, and difficulty is experienced in securing the most suitable representatives, or avoiding selection on mere Imperial political grounds, having no connection whatever with the local management of the district.

The editor of the *Municipal Journal* compares the ordinary town councillor with the directors of a public company, and appears to think that "Lords, members of Parliament, solicitors, superannuated admirals, and military men predominate on electric lighting companies, and that even a keeper of a restaurant is a managing director, whereas the Town Councils attract the men of highest standing and best business trading."

Neither the facts nor the inference are correct. Trading companies select their directors from several classes; but all interested personally in the business which they are carrying on, either as technical experts, men of great business capacity, or capitalists—and this is especially the case with electric companies. There is no question that among town councillors able men representing the special industries of the locality are to be found, but too often they are selected without reference to their special knowledge on any subject, but merely because they are Unionists or Radicals, or have been members of the representative body for a number of years. As a rule they know absolutely nothing about electricity, and depend entirely upon the consulting engineer they call in, who, as a rule, advises the speculation, which necessarily accords with his own personal interest.

In our judgment, no municipal trading should be permitted until the ratepayers have been fully consulted upon it, and have recorded an emphatic vote in its favour. Instances are by no means uncommon of the action of a majority on a Town Council being overruled by the ratepayers when they have had an opportunity of recording their opinion, but it is also unfortunately the case that their opinions do not always prevail.

The editor of the *Municipal Journal* deals with some of the objections to municipal trading, but cannot be convinced against his will that the local authority is not the best of all possible worlds. The idea of a candidate for a Town Council being influenced by the labour or any other vote! Who could think for a moment that a coming mayor would influence corporation contracts to his own firm or their associates? Perish the thought! How municipal trading can injure industry he cannot see, except as to the middlemen, and who are they, but all the retail shopkeepers in the town. The electric fittings and wiring shops would naturally lose their trade if the borough engineer undertook their business and sold 1s. lamps at cost price.

The concluding remarks of the editor of the *Municipal Journal* upon the development of cheap electric power over wide areas exhibit some misgivings as to the impregnable position of the advocates of municipal trading. He hints at the jealousies of local councils as giving great scope for private enterprise in linking small towns and districts together, both for electricity and light railways, and here we recognise a gleam of reason. A combination of local authorities, with all sorts of differing circumstances to deal with, could never carry out such schemes as that of the East Middlesex Bill, which the ratepayers disposed of a few months ago, and we are sure that the true interests of municipal life were never more protected than by the aggressive action of a company which on that occasion frustrated such an undertaking.

Apart altogether from the great principles involved in the adoption of Mr. John Burns's ideal of the abolition of private trading, and the establishment of a State system in its place, the minor question is involved in this discussion, viz., as to whether, in the matter of electricity supply, any municipality has yet been able to carry on the business with financial success.

Mr. Morse has entirely disposed of the assertion that the supply of gas, electricity, and tramways can be better provided by a municipality than by a company.

There is a certain amount of difficulty in getting at the exact figures connected with any section of a municipality's undertakings, as Mr. Morse, in dealing with gas, argues "on the assumption that the municipal accounts charge to the gas undertaking every expense properly chargeable thereto, about which there must always be considerable doubt, until the municipal accounts are not only independently audited, but are made public."

This is a very large assumption, for it is well known that the accounts are frequently kept in a way that prevents the real state of the trading being known. The deficiencies are covered by fresh borrowings or large balances due to the treasurer, and not only amounts carried to capital account, which should be charged upon revenue, but only in very rare instances is any provision whatever made to meet depreciation of plant from antiquation, wear and tear, and consequent renewals.

It is unfortunate that the Government does not publish regularly similar returns to that issued on the suggestion of Sir Henry Fowler in 1899, as the figures showed that the aggregate amount allowed for depreciation by local authorities on the electric lighting accounts to March 31st, 1898, was only equal to *one-eighth of 1 per cent. per annum*, and the average annual margin of surplus, inclusive of the small amount allowed for depreciation, was only *one-third of 1 per cent. per annum on the total capital expended.*

Against these figures, which are absolutely incontestable, local authorities have been supplied by interested parties with statements intended to prove that a majority of municipalities supplying electricity do so at a profit in relief of rates, and, in some cases, amounts have been actually credited to the rates, for which there was no justification if the accounts had truly represented the results of the trading.

One of our contemporaries has long published a table of costs, being an analysis of the accounts of electricity supply undertakings established under provisional orders in the United Kingdom, and this table has been constantly referred to by the advocates of municipal trading in support of their views. Two columns of statistics are chiefly made use of, viz., "Surplus for year," and "Deficit for year." The towns whose accounts show a surplus are paraded in proof of the success of the trading, and the deficits are either explained away, or being deducted from the net surpluses, a net result satisfactory for the argument is used as the temptation to local authorities for embarking in the speculation.

But these tables are not only incomplete, but delusive; for example, there is in one column the "*amount provided for depreciation and sinking fund*," but nothing whatever to show whether any amount at all has been provided for depreciation.

Take, as an example, Canterbury, second year, surplus for the year, £14; amount provided for depreciation and sinking fund, £990; but on examination of the official accounts, we find that *nothing whatever has been provided for depreciation*, the item referred to in the table of costs being specified in the official accounts under net revenue account, as instalments of principal of money borrowed, £989 15s. 10d.

We advise ratepayers to carefully analyse the accounts of all municipal electric light undertakings before believing that in any one instance the speculation has been a financial success, and not an actual burden on the town.

The *Municipal Journal* comments upon our article of 6th inst., and affords another illustration of the old adage, "A

in which he includes gas, electric light, and tramways; but

provisions, clothing, shelter, and suitable occupations come

man convinced against his will, is of the same opinion still."

If the repetition of a fallacy could convince people that it is a sound principle, the *Municipal Journal* would establish its case.

Judging from the action of local authorities, there is substantial evidence that they are beginning to understand the fact that payment of the original cost of plant by instalments does not provide for antiquation, depreciation and renewal.

The *Municipal Journal* alleges that a municipal authority only requires about 4 or 5 per cent. for its interest and sinking fund, and we would ask upon what it bases its statement? The ordinary calculation for provision of interest and sinking fund, upon a loan for 25 years, is $6\frac{1}{2}$ per cent., and our contemporary will find that amount specified in estimates of probable financial results in the reports of leading consulting engineers to the local authorities they advise.

The *Municipal Journal* admits that the private trader has an advantage over the municipality in not having to pay interest unless profits are realised, but nevertheless contends that the municipalities are able to supply the public at lower rates than the private companies. But may it not be a fact that if this were so, local authorities have been charging too little, and that the men who understand their business have adopted the proper tariff. It is at least significant that many local authorities have recently raised their charges, finding that the cheap rates do not pay. The blame is cast upon the price of coal, but this applies equally to the companies who have not raised the price to consumers.

CONTINUOUS-CURRENT DYNAMOS.

By CLAUDE W. HILL.

A paper under the above title, an abstract of which appears on another page, was read by Mr. H. A. Mavor, at the Glasgow Engineering Congress.

In this paper the author aims at a standard system of dynamo design and manufacture with a view to establishing a definite basis of comparison between the machines of different makes.

The most important point is that in which the author proposes in designing machines, to commence at the commutating parts, and having settled their proportions suitably for sparkless collection, to build the remaining parts of the machine around them. This is, in principle, the method adopted by myself in 1892, when I joined Messrs. Paterson & Cooper as manager and became responsible for the design of their machines, although my procedure was in detail rather different from that proposed by Mr. Mavor, which is based by him upon the methods described in Messrs. Parshall & Hobart's work on "Electric Generators."

Mr. Mavor determines the non-sparking proportions from the relationship of the average E.M.F. generated per section of the armature e to the reactance voltage of a section undergoing commutation r.

At first sight it is a little difficult to see what these two values have to do with each other, but when we take also the author's statement that the ampere-turns per pole of the armature (that is to say, the ampere-turns producing cross turn reaction), should not exceed 25,400 per inch length of air space, the matter becomes clearer.

As the number of turns per section of the armature is the same when in the magnetic field, and also when undergoing commutation, and as in both positions it is going at the same speed, the ratio $\frac{e}{r}$ simply represents the relationship between the strength of field in the gap, and that produced by the ampere-turns in the section being commutated.

Practically, the author tells us that, after allowing for a cross turn reaction equal to 25,400 ampere-turns per inch length of air-gap, we must further make the field in the gap so strong that the E.M.F. generated per section of the armature is twice the reactance voltage of a section which is being commutated. These empirical values are expressed in rather a roundabout manner, and it appears to me that it would be simpler and more direct to use magnetic values, although they would be equally empirical but would entail less work.

I find that the values obtained for r in Mr. Mavor's formula No. 3 do not correspond with the values found by Messrs. Parshall & Hobart's method of calculation, from which I conclude there is a misprint in the proof of Mr. Mavor's paper which has been sent to me.

Taking the basis formula for maximum alternating voltage $= \frac{2 \pi N C}{s \times 10^8}$, I have constructed the formula

$$r = \frac{\cdot 1645 \times D R f l c m_1 m_2}{t} \times 10^{-8},$$

in which D = diameter of commutator in inches, R = revolutions per minute, f = C.G.S. lines per inch length of armature induced by one ampere-turn, l = length of armature in inches, c = current in each conductor, m_1 = the number of magnetising turns in the portion of the armature undergoing commutation, which depend on the number of bars covered by the brush, m_2 = the number of turns per section of the commutator, and t = thickness of brush in inches.

The values found by this formula coincide with those found by Messrs. Parshall & Hobart, and I have used it in the calculation of the following table, in which the ratio, $\frac{e}{r}$, and the armature ampere-turns per pole per inch length of air-gap are given for a number of machines which have been run at loads so arranged as to cause these values to differ very widely.

This method of calculation can be simplified and rendered more accurate, and in its final form coincides with the method which I have used with uniformly satisfactory results for several years.

For our present purpose we really require to know the ratio $\frac{e}{r}$ rather than the individual values of e and r. The value of $e = \frac{N m_2 2}{s \times 10^8}$, in which N = C.G.S. lines cut by an armature section in the field during the same time that a section in the interpolar space is undergoing commutation, m_2 = turns per section as before, s = the time in seconds. Taking $r = \frac{\pi N_1 m_2}{s \times 10^8}$, in which $N_1 = f l c m$, and combining, we get $\frac{e}{r} = \frac{2 N}{\pi N_1}$. As the quantity $\frac{2}{\pi}$ is the same in each case, we may eliminate it.

We now get a fresh ratio $\frac{N}{N_1}$, which includes all the essentials of $\frac{e}{r}$ although it does not correspond in numerical value, which is immaterial, as the values are in any case merely empirical. We may now take it that a machine will be sparkless if the ratio $\frac{N}{N_1}$ is of a value such that $\frac{e}{r}$ would equal 2 when the cross turn reaction of the armature does not exceed 25,400 ampere-turns per pole per inch length of gap.

We may go a step further, and instead of assuming a certain gap density and a certain cross turn reaction, take the actual figures of both these values. N in the air-gap is proportional to ampere-turns and N_1 in the commutating space is assumed to be (and probably is) also proportional to ampere-turns. Armature cross turn reaction is expressed in ampere-turns, and so taking A = total ampere-turns in gap, A_1 = armature reaction expressed in ampere-turns, and A_2 = the magnetising ampere-turns in that portion of the armature undergoing commutation, we obtain the ratio $\frac{A - A_1}{A_2}$ which takes into account the true value of the cross-turn reaction, and so enables us to determine sparkless proportions for machines working with varying excitation, such as machines which with full strength of field give 135 volts for charging accumulators, and with weakened field 100 volts

authorities, with all sorts of differing circumstances to deal

inst., and affords another illustration of the old adage, "A

for direct lighting, or those which with full field have to give 550 volts for traction work, and with weakened field 440 volts for lighting.

The formula $\frac{A - A_1}{A_2}$ is the one which I have used, but I arrived at it directly, and not by the method indicated here. It occurred to me that as it was the work of the reversing field to accomplish sparkless commutation, it should bear some definite relation to the magnetising ampere-turns in the portion of the armature undergoing commutation, and commencing in 1892, I had a number of experiments made with different machines to determine the relation. After accumulating a sufficient number of results, I found that for any given type of machine, the ratio was a constant quantity irrespective of size, and I pointed this out in an article which I contributed to the ELECTRICAL REVIEW in August, 1895.

The above expressions, however, whether we take $\frac{e}{r}$ or $\frac{A - A_1}{A_2}$, do not include the whole of the magnetic conditions which have to be taken into consideration in order to obtain sparkless collection. This we may see from the example No. 6.

The constants of this machine are such as would lead us to expect that it would be absolutely sparkless, and yet it is a slight sparker, the sparking being due to magnetic conditions and not to mere mechanical defects.

We may, therefore, say that although for sparkless collection $\frac{A - A_1}{A_2}$ must not be less than a given figure, still there will be sparking if the other magnetic conditions, such as number and density of teeth, &c., do not receive careful consideration.

Respecting the question of cost of machines, I have found that where a range of machines is designed in fairly regular proportion, the cost of labour and material go up in a fairly regular manner, as shown on the curve fig. 3. I have used curves of this character with very satisfactory results for the purpose of estimating the cost of new machines.

Where different outputs are obtained by varying the length of armature, while keeping the cross-section of the machine constant, the costs vary in a different degree. In fact, I have found that for a given cross-section of machine the length of armature may be varied considerably without making any great difference in the cost of labour, and as the bearings and various other parts are not altered, the cost of material does not vary in direct proportion to the length of armature; so that, provided due account is taken of other conditions, principal among which is the reactance voltage, a machine with an armature of small diameter and long length will, for a given output, be cheaper to construct than one having a short armature whose diameter is proportionately larger.

No.	Mr. Mavor's formulæ. $\frac{e}{r}$	Mr. Mavor's formulæ. $\frac{G\,m\,C}{p\,A\,P}$	$\frac{A - A_1}{A_2}$	Remarks.
1	4·1	12,000	6·2	Absolutely sparkless
2	4·3	9,700	6·1	" "
3	1·72	12,801	3·5	Slight spark.
4	1·63	15,880	1·48	Bad sparking.
5	1·1	27,600	0·505	Very bad sparking.
6	4·3	7,920	8 8	Slight spark.

SOME NOTES ON CALCIUM CARBIDE MANUFACTURE.

AN interesting article entitled "The Influence of the Nature of the Electric Current on the Manufacture of Calcium Carbide," by M. J. Pradon, of Paris, has recently been published in the *Zeitschrift für Calciumcarbid Fabrikation*. Dealing first with continuous currents, the author discusses the possibility of electrolytic action. Taking a 150-KW. furnace, and assuming a yield of 5 kilos of carbide per KW. day, if the current is introduced at a voltage of 50, 5·7 per cent. of the make may be dissociated into elemental calcium; whereas at a voltage of 25, 11·5 per cent. of the carbide may be wasted. These figures, however, are purely theoretical; for with vertical electrodes, when the hearth of the furnace is made the negative pole, the calcium remains in suspension in the bath, and if an excess of carbon has been used in compounding the charge, the metal combines again with part of that excess. If the upper electrode is the negative one, the reduced calcium tends to pass away in vapour; but as the charge is always granulated, the metal is condensed before it can escape. Clearly electrolytic action is not so objectionable a phenomenon as was originally expected; its effects can easily be neutralised, and it only causes a somewhat higher consumption of carbon per ton of carbide produced. Under precisely similar conditions in the furnace, and with the identical charges, continuous current carbide is of lower quality than that prepared with an alternating current. A continuous current yields a compact carbide which is very difficult to break; an alternating current produces a crystalline carbide which breaks [or cleaves] more readily. The gas yield from alternating current carbide is generally 15 or 20 litres per kilo. higher. If a direct current furnace is fed first with a charge too rich in lime, a reddish mixture of carbide and fused calcium oxide is formed, which only evolves some 100 litres of gas per kilo. If then a fresh charge unduly rich in carbon is added, a better dark-coloured carbide is produced; and when the whole output is allowed to cool a sharp line of demarcation can be seen between the two materials, which separate with a gentle blow. But if the experiment is repeated with alternating currents there is no such line of demarcation, and although the lowest (first) part of the make evolves very little acetylene, the quality gradually improves towards the top of the mass. It is also well known that the furnace charge must be absolutely homogeneous in composition when direct currents are employed; with alternating currents a rough mixing is quite sufficient.

The author next proceeds to discuss the question of alternating *versus* direct currents from the aspect of the generating plant. This part of his article we may omit, for his remarks are not specially new to electricians. He merely shows that sudden changes in the resistance of the furnace are commoner in the manufacture of calcium carbide than perhaps in any other electro-chemical operation; that the alternator can bear these changes better than the direct current machine; that less labour is absorbed in watching the generators when they yield alternating currents, and that the only objection to the alternator is the loss of energy due to lag. It frequently happens that when a furnace is fed with an alternating current of 35 volts, at the ends of the electrodes the tension is only 25 volts. When a direct current is employed the drop in potential will not exceed 1 or 2 volts. Therefore the alternator installed to serve a certain furnace must be larger than corresponds to the consumption of energy inside the furnace itself. Phenomena of self-induction may appear both in the circuit and in the furnace. The former loss can be diminished by the use of strip conductors, but that of the arc is also important, for the cos θ of the furnace may show a value approaching 0·8. With the idea of stopping this waste of energy, M. Pradon has designed and patented a furnace built according to the idea which underlies the use of concentric cables for alternating currents. The hearth of the furnace is, as usual, a truck running on wheels, and its sides are constructed of metal walls. When in position the truck stands under a metallic chimney, through which the gases ultimately pass off, and in the middle of which hangs the vertical electrode. One lead for the current is attached to the top end of the furnace sides. The other is fastened to the lower end of the chimney. The current is thus compelled to pass downwards through the metallic sides of the furnace, into the central hearth, up through the mixture of lime and coke, up through the second electrode, down through the walls of the chimney, and so away; and thus in every position the central current is opposed by an "annular" current always travelling in the opposite direction. By this arrangement the author claims

that considerable economy can be effected in the generating plant; for an alternator may be safely installed, the dimensions of which have been calculated from the $\cos \theta = 0{\cdot}85$ factor. If, however, the lag of the furnace has not been eliminated, it is necessary to employ in calculation the factor $\cos \theta = 0{\cdot}70$.

When cold, the mixture of lime and coke used in manufacturing calcium carbide is a bad conductor of electricity, but when heated by the proximity of the arc, it conducts fairly well. In such a furnace as has been described, therefore, there is apt to be a leakage of current from the hearth through the hot charge; and although this amount of energy is not theoretically wasted—for it yields the equivalent quantity of heat according to Joule's law—it is practically useless as it produces a hard crust of material, partly true carbide and partly undecomposed lime and coke which cannot be sold. To prevent this leakage, M. Pradon suggests "insulating" the upper electrode, and thus confining the current to the arc proper.

In furnaces with vertical electrodes, as the proportion of carbon in the charge increases, the walls of the furnace become hotter, and the make of carbide per unit of power falls. Conversely, as all makers know, if the proportion of lime is increased, the production of gas is diminished, and the output of carbide is raised. It seems possible, therefore, that there should be advantages in producing a lower grade of calcium carbide than is made at present, a material yielding only 250 litres of the gas per kilo. (4 cub. ft. per lb.); for in this way the manufacturing costs, and so the selling costs, might be more than proportionately reduced. [There does not appear to be any objection to this proposal, which, indeed, has been offered before, always provided that the carbide be sold at a price calculated upon its gas-making power, with an allowance for the extra expense in transporting a heavier weight of less concentrated material by rail or ship. Evidently the logical method of charging for carbide, whenever it is used for preparing acetylene, is really to base the price on the volume of gas evolved per unit of weight under prescribed conditions of generation.]

Another method of avoiding the self-induction of the arc is to suppress the arc altogether, and to perform the operation in a "resistance" furnace, of which the molten charge forms the actual resistance. This plan is practically impossible of achievement; for although the minimum voltage required to strike an arc in a lamp is about 35, in the carbide furnace, owing, presumably, to the presence of calcium and carbon vapours, the author believes that an arc would appear with a voltage of 8 or 10. Thus the leads and connections of the furnace would have to be so large that the plant would become very expensive. When in a furnace working at 6,000 amperes and 28 volts the upper electrode is lowered to within 40 mm. of the hearth, the needle of the voltmeter stands at 15. If, then, at 28 volts there were no arc, this drop in potential of 13 volts must be caused by the resistance of the calcium carbide, which, in the case under consideration, formed a mass of 5,000 sq. cm. by 4 cm. thick; and, were the specific resistance of carbide known, it would be possible to calculate what this drop should be. M. Pradon has endeavoured to determine the latter value by forming a bath of carbide 40 × 40 cm. by 60 cm. deep in a furnace taking 1,800 amperes. When a voltmeter was connected to the hearth of the furnace, and through a carbon rod to the surface of the molten carbide, the needle indicated 6 volts. Allowing 1 volt for the drop in the hearth itself, the loss of potential in the carbide is 5 volts, whence

$$\rho = \frac{5 \times 1{,}600}{1{,}800 \times 60} = 0{\cdot}075 \text{ ohm per c.c.}$$

From this specific resistance it follows that a bath of carbide, 4 cm. deep, and 5,000 sq. cm. in area, with a current of 6,000 amperes, should absorb

$$\frac{0{\cdot}075 \times 6{,}000 \times 4}{5{,}000} = 0{\cdot}36 \text{ volt};$$

so that the drop in potential, if there were no arc at a pressure of 28 volts, would be only 0·36 volt—an amount that would be scarcely noticeable.

GERMAN ELECTRICAL FINANCE.

The general depression which commenced in German iron and other industrial circles a year and a half ago has not been without its effect upon the electrical engineering branch, which has suffered in consequence of the excessive speculation which has been in progress in that country for several years past. A climax was reached two or three months ago, when one electrical company was compelled to go into liquidation, notwithstanding the attempts made by the two principal electrical companies in Berlin to reorganise the business, and as there appears to be no prospect of a purchaser, the liquidators announce that the present limited output at the works will be discontinued at the end of September in the event of the undertaking not being disposed of in the meantime. The collapse of this company has been followed by that of several banks, and proposals to wind up have also been made by one or two other electrical concerns of less importance, and these are still under consideration. The occurrence of these unfortunate events has not tended to dissipate the feeling of distrust which has been assumed by investors towards electrical investments for some time past. On the contrary, no one will look at an electrical security at the present time, and there is little hope of any improvement until the confidence of the public has been restored. Whilst the idea of apparent insecurity dominates the minds of investors the industrial banks are marking time, and all their resources may be required to weather the storm which is passing over the country. On their part the manufacturing companies have, generally speaking, found business slacker this year, and there have been many dismissals of workmen, but the full effects of the depression will scarcely be known until next year. The results of the past year's working of some of the large companies have not yet been published, but the following summary indicates the position in regard to some of the other undertakings.

The shareholders in the Schuckert Company, of Nuremberg, experienced an unpleasant surprise at the recent meeting, when it was announced that the proposal to pay a dividend of 10 per cent. would be withdrawn, and the amount carried forward to the next account. It was explained by the directors that when the decision to declare the dividend was arrived at it was not expected that the crisis in trade and industry would last so long and have so unfavourable an influence upon the financial position of the company. In the meantime the collapse of the Leipsic Bank nearly caused a panic, and induced each institution to consider the future. The explanation proceeded to state that the Schuckert Company was only interested in the failure of the bank to the extent of having purchased shares amounting to £210,000 in the Jaice Electricity Company which had to be paid for immediately in order to obtain possession, and the injury suffered by the company lies in the premature payment for these shares. In these circumstances it was not proposed to pay the proposed dividend, but to retain the whole of the surplus in the interests of the company. At the meeting the directors were subjected to, and answered, long criticisms directed against the alleged high proportion of officials in relation to workmen, the high salaries of officials, too little provision for depreciation of plant and machinery, and an excessive valuation of the shares held in the allied concern—the Continental Company for Electrical Enterprises—to which reference is made below. One attempt was made to secure the payment of 5 per cent. on the capital, another proposed the writing off of the whole of the available balance; but these amendments were rejected, and the new recommendation not to declare any dividend was eventually approved. The accounts which were issued prior to the meeting showed that the company's capital amounts to £2,100,000, and loans to £1,750,000. The surplus for the year reached £538,776 as compared with £630,412 in the previous year, and the net profits were £312,185 as against £462,451. It was proposed to distribute £210,000 by way of a 10 per cent. dividend in comparison with 15 per cent. last year, and to carry the balance forward. There has, however, been no distribution, and the company has no reason to rejoice in the possession of the Jaice shares, which company is mainly concerned with the electrical production of carbide of calcium, which is now one of the depressed and over-produced industries on the Continent.

The Continental Company for Electrical Enterprises, of Nuremberg—one of the various promoting undertakings—experienced a serious set-back during the past year. Including the balance brought forward, the surplus available as a result of the year's operations amounts only to £77,689 as compared with £192,534 in the previous year. After meeting expenses of administration and interest on loans, there remains a net profit of £37,000 as against £151,718. Of the profit, the sum of £30,154 is absorbed by renewals, capital redemption of undertakings administered by the company and allocations to reserve, whilst the balance is carried forward to the next account. This is an exceedingly unfavourable result when compared with the distribution made in the previous year at the rate of 7 per cent. The report of the company, whose capital of £1,600,000 is mostly held by the Schuckert Company, points out that only a portion of the securities held could be realised during the year, and that the profits on new issues were less, in consequence of investors having abandoned their preference for electrical enterprises in favour of an opinion adverse to them. Moreover, the surplus out of working operations did not correspond to expectations, owing to increased expenses, whilst the writing down of shares to the level of quotations brought about a considerable loss. The directors believe, however, that the disinclination of the public to invest in electrical securities will change to a more favourable view when it becomes more generally known that the majority of electrical undertakings may be regarded as solid, and capable of

development. It cannot be seen how soon such a change will take place, so as to allow of the realisation of the shares held in other companies; but in view of the interest manifested in various foreign undertakings, the directors consider that an advantageous disposal may shortly become possible. The company is interested in lighting and tramway concerns in Germany, Russia, Austria, France, Italy, Spain, Norway, and Roumania.

The Lahmeyer Company, of Frankfort-on-the-Main, whose share capital has rapidly advanced from £85,000 to £500,000 during the past six years, has no reason to be dissatisfied, notwithstanding the slight decline during the past year. It has paid dividends successively of 5, 8, 10, 11 and 11 per cent., whilst the distribution diminishes to 10 per cent. for the year which recently terminated. The company's report characterises the present situation as satisfactory, even after taking into consideration the retrogression which has occurred in the industry. The shops only partially require night work, new orders continue to increase, and employment is now found for 2,726 workmen and officials, as compared with 2,264 a year ago. Complaint is made of the tardy manner in which payments are made, especially in regard to the heavy industries. This fact, notwithstanding the activity and perfection of manufacture, renders it difficult to form a correct judgment of the course of business during the current year. There is, however, no ground for despondency, as when the anticipated improvement takes place the report submits that the well established works will maintain their recognised standard of efficiency. The gross profits for the year reached £215,805, as compared with £162,437, being an increase of £53,368, whereas the expenditure only advanced by £16,400. After providing for depreciation and payment of guaranteed interest, there remains a net profit of £70,030. This is disposed of by the payment of £50,000 as dividend on the capital of £500,000 as against £33,000 on £300,000 in the preceding year, whilst the balance is absorbed by additional appropriations for depreciation, the remuneration of the directors, and the carry forward to the next account. It is noteworthy that the company's patents have been entirely written off the books. The report mentions the receipt of an order from the Charing Cross and City Electric Lighting Company for the supply of machinery, and states that, as a result of this contract, and in order better to be able to deal with business in England, it was found advisable to form an English concern under the title of the Lahmeyer Electrical Company, with a capital of £100,000. A similar policy has been followed in Italy by the constitution of a Lahmeyer Company in Milan. On the other hand, the Russian section has resulted in a considerable loss in consequence of the heavy expenses, unsatisfactory organisation, and the general economic depression, and a similar fate has attended the company's investment in the Norwegian electrical company at Skien. The company has now decided to increase its capital to £1,000,000, in order to exchange the additional shares for a large share in the German Company for Electrical Enterprises of Frankfort-on-the-Maine.

The first general meeting of the Felten & Guilleaume Gesellschaft, of Mulheim-on-the-Rhine, as now constituted, was held recently, when accounts were passed covering a period of 18 months. With a capital of £1,800,000, the profits earned by the company during that period amount to £400,308, of which £42,554, has been written off for depreciation to the extent of 2½ per cent. on buildings and 12 per cent. on machinery. Out of the balance of £357,754 the shareholders receive £225,000 by way of dividend at the rate of 10 per cent. per annum, or 15 per cent. for the period under review, although the capital participating in the distribution on this occasion only amounts to £1,500,000. The sum of £17,882 has been placed to reserve, and £50,000 to the special reserve fund, the directors' remuneration absorbs £20,750, and the officials' pension fund £5,000, whilst the balance has been carried to the next account. As compared with liabilities amounting to £840,000, the balance-sheet showed debtors for £1,147,500.

The operations of the Internationale Elektricitäts Gesellschaft, of Berlin, in which the well-known Disconto Gesellschaft is prominently interested, were mainly concerned during the year with its participation in the Compagnie Parisienne de l'Air Comprimé Popp. Although the Popp Company is of long standing, it will be unable to pay any dividends until the question of the extension of its concession by the Paris Municipality has been satisfactorily solved. During the year a net profit of £81,210 was realised by the Paris Company as against £57,320 in the previous 12 months, but of the former only £4,290 was derived from the compressed air portion of the undertaking as compared with £4,540. It is expected that the latter branch will show considerable development this year in consequence of the number of lifts supplied with power having been doubled. It will be understood that the greater portion of the revenue has proceeded from the sale of current, the lamp connection having advanced from 174,909 to 240,070 lamps. The net profits of the the Popp Company have been placed to the redemption fund, which has thereby been increased to £136,400. The unsatisfactory condition of the Paris Company has induced the International Electrical Company to again devote its surplus for the year to writing down the value of the shares held in the Popp Company. As the surplus, which mainly arises from interest, amounts to £10,880 as against £9,118 in the preceding year, it will be obvious that this Berlin company is having to pay dearly for its experience with the French compressed air company.

The well-known electrical instrument business of Hartmann and Braun, of Frankfort-on-the-Maine, was converted into a joint stock company in June, with a share capital of £85,000, and at the same time a 5 per cent. loan of £35,000 was sanctioned, repayable within 35 years from 1906. The purchase price was fixed at £116,400, of which £84,850 has been accepted by the vendors in shares and the remainder in bonds. The board of inspection comprises Herr Eugen Hartmann and Dr. Franz Braun, whose families retain possession of the shares for the present.

The Deutsch-Ueberseeische E.G., of Berlin, which stands in close relations with the Allgemeine (A.E.G.) Company of that city, owned only one of the central stations in Buenos Ayres until recently, when an arrangement was entered into for the absorption of the undertaking of the Compagnie Générale d'Electricité de la Ville de Buenos Aires of Paris. The latter was also established by a German company, the Union E.G., which, together with its friends, owned the majority of the shares in the French company. The amalgamation will have the effect of diminishing competition and bring about economy of administration of the two enterprises, one of which is on the continuous current, and the other on the alternating current system. The German company, which completed extensions last year, increasing the total capacity up to 7,000 H.P., realised a net profit of £11,176, and its lamp connection advanced to the equivalent of 74,000 lamps of 16 C.P. The gross receipts amounted to £34,692, of which £28,122 was obtained from lighting, and the remainder from the operation of the metropolitan tramway.

The first annual report of the Voight & Haeffner Company, of Frankfort-Bockenheim, regards the results obtained as being satisfactory, although the reaction in industry has been experienced as in the case of other concerns. The company's second factory, which was commenced at the beginning of the financial year, was completed in the autumn, and the transfer of a portion of the business from the old to the new works was then taken in hand. The new factory has been specially designed for the manufacture of apparatus for dealing with heavy currents and high tensions, and is equipped with an extensive laboratory and test rooms. The surplus from manufacturing operations during the year amounted to £27,770, and the net profits to £11,918, the dividend paid being at the rate of 8 per cent. It is expected now the new factory is at work, and in view of the manifold nature of the company's manufactures, that the scope of business will be considerably extended.

The position of the Heddernheimer Kupferwerke (late F. A. Hesse & Sons) of Heddernheim, has been so far from satisfactory as to render a reorganisation necessary in order to place it on a stable financial basis. At the close of 1900 there was a deficit amounting to nearly £44,000, and in order to bring about reform the recent general meeting agreed to a reduction of the share capital from £300,000 to £200,000, and to the issue of preference capital to the extent of £50,000. The proceeds of this issue, which has just been offered to existing shareholders at par, are to be devoted to the wiping out of the deficit, the defraying of the expenses of reorganisation, and the formation of a special reserve fund to be added to every year. Under certain circumstances it will be possible for a general meeting to extinguish the preferential right of the new capital and place it on an equality with the ordinary shares.

THE BRITISH ASSOCIATION MEETING.

The Glasgow meeting of the B.A. closed on Wednesday. As might have been expected, after the holding of the Engineering Congress in the same city but a few days previously, the gathering was even less important than usual from an electrical point of view. The presidential address, to which we referred last week, was delivered by Prof. A. W. Rücker on 11th inst. to an audience of between 2,000 and 3,000.

Major MacMahon's Address in Section A.

In Section A the following morning Major P. A. MacMahon, D.Sc., F.R.S., delivered his presidential address, in the course of which he said, among other things:—

In pure science we look for a free interchange of ideas, but in applied physics the case is otherwise, owing to the fact that the commercial spirit largely enters into them. In a recent address Prof. Perry has stated that the standard of knowledge in electrical engineering in this country is not as high as it is elsewhere, and all men of science and many men in the street know that he is right. This is a serious state of affairs, to which the members of this Section cannot be in any sense indifferent. We cannot urge that it is a matter with which another section of the Association is concerned to a larger degree. It is our duty to take an active, and not merely passive, attitude towards this serious blot on the page of applied science in England. For this many reasons might be given, but it is sufficient to instance one, and to state that neglect of electrical engineering has a baneful effect upon research in pure science in this country. It hinders investigations in pure physics by veiling from observation new phenomena which arise naturally, and by putting out of our reach means of experimenting with new combinations on a large scale. Prof. Perry has assigned several reasons for the present *impasse*, viz., a want of knowledge of mathematics on the part of the rising generation of engineers; the bad teaching of mathematics, and the antiquated methods of education generally; want of recognition of the fact that engineering is not on stereotyped lines, but, in its electrical aspect, is advancing at a prodigious rate; municipal procrastination, and so on. He confesses, moreover, that he does not see his way out of the difficulty, and is evidently in a condition of gloomy apprehension.

It is, I think, undoubted that science has been neglected in this country, and that we are reaping as we have sowed. The importance of science teaching in secondary schools has been overlooked. Those concerned in our industries have not seen the advantage of treating their workshops and manufactories as laboratories of research. The Government has given too meagre e-

endowment to scientific institutions, and has failed to adequately encourage scientific men and to attract a satisfactory quota of the best intellects of the country to the study of science. Moreover, private benefactors have not been as numerous as in some other countries in respect of those departments of scientific work which are either non-utilitarian or not immediately or obviously so. We have been lacking alike in science organisation and in effective co-operation in work.

It has been attempted to overcome defects in training for scientific pursuits by the construction of royal roads to scientific knowledge. Engineering students have been urged to forego the study of Euclid, and, as a substitute, to practise drawing triangles and squares; it has been pointed out to them that mathematical study has but one object, viz., the practical carrying out of mathematical operations; that a collection of mathematical rules of thumb is what they should aim at; that a knowledge of the meaning of processes may be left out of account so long as a sufficient grasp of the application of the resulting rules is acquired. In particular, it has been stated that the study of the fundamental principles of the infinitesimal calculus may be profitably deferred indefinitely so long as the student is able to differentiate and integrate a few of the simplest functions that are met with in pure and applied physics. The advocates of these views are, to my mind, urging a process of "cramming" for the work of life which compares unfavourably with that adopted by the so-called "crammers" for examinations; the latter I believe to be, as a rule, much maligned individuals, who succeed by good organisation, hard work, and personal influence, where the majority of public and private schools fail; the examinations for which their students compete encourage them to teach their pupils to think, and not to rely principally upon remembering rules. The best objects of education, I believe, are the habits of thought and observation, the teaching of how to think, and the cultivation of the memory; the examiners of experience are able to a considerable extent to influence the teaching in these respects; they show the teachers the direction in which they should look for success. The result has been that the "crammer" for examinations, if he ever existed, has disappeared.

Col. Crompton's Address in Engineering Section (G).

In Section G (Engineering) the same morning Col. Crompton delivered his sectional address, of which the following is an abstract:—

I wish to lay before you some of the interesting problems presented by recent developments in means of locomotion on land which demand the best thoughts of everyone interested in the improvement in means of travelling and in the more rapid transit of goods.

Of late years our attention has not been confined to railways only, but, owing to the invention of the cycle and motor car, has also been directed to travel on our roadways, which during the first 50 years of the railway era had somewhat fallen into disuse. I am not able here to deal with many of the interesting questions affecting our long-distance railways, other than by referring to the probable early introduction of railways of a new type intended to attain a speed of 120 miles per hour and worked by electrical power. It appears that, after all, the speed limit of railways of the present system of construction is reached at about 65 or 70 miles per hour. It is not probable that anything greatly in excess of 70 miles per hour will be reached until railway managers initiate an entirely new system of construction. The high-speed service that is now in contemplation in England, America, and Germany, intends to attain speeds of over 100 miles per hour by providing electrical means of haulage sufficient to propel light trains consisting of one, or, at the most, a few cars; and in order to render this service successful to run these light trains at short intervals of time; so in effecting this high speed the railways will give a service which more nearly resembles the tramway service than our present system of heavy express trains at infrequent intervals. The high-speed service of light trains at frequent intervals is well suited to electrical haulage, as it works generating machinery situated at fixed points to the best advantage, and enables the best return to be obtained from the necessarily heavy capital cost of copper in the conductors which transmit the energy along the length of the line, as it is evident that if the speed be sufficient to ensure that each section of the line only carries one running train, the costs of the conductors will be in proportion to the weight of that train.

Great advantages have already been made in adapting electrical traction to long lengths of railways. The work already done by Brown-Boveri, of Baden, in Switzerland, at first on the mountain railways and afterwards on the Burgdorf-Thun full-gauge line, the experimental work of Ganz & Co., of Buda-Pesth, and of Siemens and Halske, at Charlottenburg, have already shown that the power problems are nearly all of them solved, so that we may feel confident that electrical engineers will very shortly surmount any power difficulties that still remain. But this high-speed railways problem at present presents certain unknown factors which can only be satisfactorily determined by the actual testing and working of the lines when carrying passengers. I refer to those which deal with the increased oscillation, vibration, and noise to be expected from the extreme speeds. These matters must be met so as to give sufficient comfort and protection to the passengers, for if the passengers are rendered uncomfortable by the extreme speed the service can never become popular, and on this last question depends the most important question of all, viz., the extent to which the travelling public are likely to make use of a high-speed railway service. In attempting to forecast this matter, although we meet many business men who think it would be an undoubted advantage if the journeys between important business centres occupied half the time they do at present, in the United Kingdom there are only a few journeys of sufficient length to make saving of time of great importance, but the case is far different in America and on the Continent, where the business centres are much further apart than they are here. I, as an English engineer, foresee that this typographical question will cause our English engineers to be at a disadvantage as compared with American and Continental ones, for it appears likely that the number and mileage of high-speed railways is likely to be far greater in America and on the Continent than in the United Kingdom. Before I entirely leave the subject of very high-speed railways, a rather curious speculation presents itself to us; this is whether the need for rapid communication between town and town may not eventually be supplied by high-speed motor cars on roads specially prepared for them. Mr. Wells in his interesting forecast in the *Fortnightly Review* seems to think that the time is not far distant when all passenger traffic will be carried on special roads on motor cars. Without going so far as Mr. Wells, it does seem probable that if only a few passengers require to travel between two business centres such as Manchester and Liverpool, and to occupy only half the time from door to door at present taken by the railway and the two terminal cab rides, it might be better to provide one of Mr. Wells's improved roads on which private owners could run their own cars, paying toll for the road, and on which a public service of cars would provide for those who did not own cars themselves.

I now propose to deal at somewhat greater length with what I think is a most important problem in locomotion, viz., that caused by the congestion of street traffic in our towns and by the undoubted difficulties which exist in carrying our workers to and from their homes in the country to their places of employment in our towns. Luckily it seems that we are likely, through the skill and energy of our engineers, to meet these difficulties in more than one way. The number of our working population that use the cycle for going to and fro from their work is already very large, and is steadily increasing, and their use of the roads must be considered. Then came the motor car, developed in France to such an amazing extent, and which seems now likely to be developed to an equal extent in this country. After many years of objecting to the use of the overhead trolley system, our town authorities seem now to have determined that the only way of relieving street traffic is by an enormous development of electrical tramways, and on all sides we find the large towns rivalling one another in the extent of the tramway systems which they have either acquired or are laying down for themselves. It seems opportune now to point out that a great deal of mischief may accrue by this indiscriminate use of tramways, and for those who are considering these matters, I bring forward a few facts which are worthy of notice. Of course, in new countries, or in new towns in old countries, where the roads are rough and bad, anything in the nature of a tramway using rails is an improvement on a roadway; but when we are dealing with cities which already possess well laid out and well-paved streets, on which all kinds of wheel traffic can be carried on with a minimum of rolling resistance, it seems wrong, from an engineering point of view, to break up the surface of these streets for the purpose of laying tramways, and for the following important reasons:—Traffic carried on a roadway by vehicles, whether horse-drawn or by cycle or motor-car, differs from traffic carried on rails, chiefly in that the former vehicles possess an important power, viz., that of *overtaking*, which is not possessed by the latter, that is to say, that vehicles on the plain road surface can overtake a stopping or a slower vehicle going in the same direction without interfering with other vehicles, whereas on rails the vehicles going one way must always remain in the same relation to one another, so that the speed of vehicles on rails must always be regulated by that of other vehicles going in the same direction. Street tramways, for instance, must stop to set down and take up passengers. This limits the speed average and the number of vehicles per mile of track, for if there be not sufficient intervals between the vehicles they would have to stop and start nearly simultaneously. Thus the carrying capacity of the best modern electrical tramway is limited by this want of overtaking power. I have made careful inquiry from those who have great experience in tramways not only in this country but in America and on the Continent, and I find that it is generally admitted that the maximum carrying capacity of an electrical tramway in one direction is 4,000 passengers per hour carried past any given point. I find that a full-gauge suburban or metropolitan railway, crowded to its fullest extent, cannot carry more than 12,000 passengers per hour. Now most of us have often seen large crowds taken away from a point of attraction by omnibuses and horse-drawn vehicles, and have noticed that the crowded omnibuses almost touch one another, and yet can go at a fair rate of speed. In this case, at eight miles per hour speed, 14,000 passengers can be carried from a given point per hour.

Up to the present a public motor-car service has not yet been installed of any magnitude to enable us to compare the carrying capacity of motor cars with that of horse-drawn omnibuses, but, owing to the reduced length of motor cars compared with that of omnibuses, and on account of their greater speed and greater control, motor cars can now be built to deal with great crowds at an even higher rate per hour than that noted above. It appears certain, therefore, that, although the provision of electrical tramways is undoubtedly an economical means of carrying passengers, yet that these tramways cannot be laid in existing thoroughfares without considerably reducing the total road carrying capacity at times of heavy pressure of traffic, and as it appears likely that either for the daily transport of the workers to and from their homes to places of employment, or for taking great crowds out into the country for pleasure purposes, a motor car service carried out on well-made roads will compete favourably with, and in many ways may be preferable to, tramway service.

It must be remembered that the laying of tram rails not only blocks ordinary traffic, but in our most crowded streets it introduces

dangers to all wheeled vehicles not on rails, motor-cars, and cyclists by the skidding of the wheels when they cross the line of rails, and these dangers are daily causing, and are still likely to cause, very serious accidents.

The increased road and street traffic, and the development of new means of road locomotion, have made imperative some modification of our existing system of roadway administration. Cycles, motor-cars, electrical tramcars, have been invented and put on roads which are maintained and worked exactly as they were 70 years ago at the commencement of the railway era, when the population of the United Kingdom was half its present figure, and that of the large towns one-tenth of the present figure.

Parliament must take in hand an improved administration of our highways by a comprehensive scheme. Far too many ancient main lines of thoroughfare, already too narrow for the traffic which is on them, are being blocked by having tramways laid on them; these cause the development of building estates, which throw additional traffic on to these thoroughfares. An increase in the speed of the street traffic is desirable; for the faster the vehicles travel the less the street is occupied by them. Motor cars can safely travel at 16 miles an hour, and, therefore, need only take half the time and occupy only half the street surface that an omnibus does when traveling at eight miles per hour. Such high speeds as these, which are desirable and perfectly safe for motor cars, cannot, however, be obtained unless some regulations are made as to the use of the roadways by foot passengers.

Much has been recently said and written on the subject of motor cars and motor wagons. It is generally admitted that there will be considerable scope for engineering skill and capital in their improvement and construction.

One of the topics which has been most strongly discussed during the last year has been the position which this country holds relatively to other countries as regards its commercial supremacy in engineering matters. A few years back we were undoubtedly ahead of the world in most branches of mechanical engineering, but owing to the huge development of mechanical engineering in America and Germany, we are certainly being run very hard by these countries, and everyone is looking for means to help us to regain our old position. In endeavouring to learn from America we see that, although the workmen in that country receive higher wages than they do here, and although the cost of some of the materials is higher than it is here, their manufacturers manage to deliver engines, tools, and machinery of all classes of excellent quality at a price which appears to our manufacturers to be marvellously low. When we look into the matter we find that the chief difference between the manufacturer of America and the manufacturer at home is that, whether it be steam engines, tools, agricultural machinery, or electrical machinery, the American invariably manufactures goods in large quantities to standard patterns, whereas we rarely do so here, at any rate to the same extent. Where we turn out articles by the dozen the American turns them out by the hundred. This difference in the extent to which an article is reduplicated is caused by the Americans having realised to a far greater extent than we have the advantage of standardisation of types of machinery. They have felt this so strongly that we find in America that work is far more specialised than it is here, so that a manufacturer as a rule provides himself with a complete outfit of machinery to turn out large numbers of one article. He lavishes his expenditure on special machinery to produce every part sufficiently accurate to dimensions to secure thorough interchangeability; consequently the cost of erecting or assembling the parts is far less than it is here. One reason why the American manufacturer has been able to impose on his purchasing public his own standard types, whereas we have not been able to do so, is that very rarely in America does a consulting engineer come between the manufacturer and the user, whereas here it is the fashion for the majority of purchasers of machinery to engage a consulting engineer to specify and inspect any machinery of importance. By this I do not impute any blame to our consulting engineer; he considers the requirements of his client, and insists that they are to be adhered to as closely as possible; to him the facility of the production of articles in large quantities is of no moment. In America it seems to be understood by the purchaser that it is a distinct advantage to everyone concerned, both manufacturer and purchaser that the purchaser should to some extent give way and modify his requirements so as to conform with the standard patterns turned out by the manufacturer. Although manufacturers all hope for this simplification of patterns, yet, for the reasons I have given, it will be some time before their hope is realised. But on other matters it is quite possible for manufacturers to combine, so as to obtain some standardisation of parts which they manufacture which will reduce costs and be of advantage to everyone concerned.

Up to the present the Board of Trade has dealt with the simple standards of weight, capacity, and length, but in other countries National Standardising Laboratories have been provided, viz., by the Germans at their Reichsanstalt at Charlottenburg, and with the happiest results; here at last, through the exertion of the Council of the Royal Society, our Government has been moved to give a grant in aid and to co-operate with the Royal Society to establish a National Physical Laboratory for this country. A laboratory is already in existence, and soon will be at work, at Bushey House, Teddington. It has large and lofty rooms and a vaulted basement in which work can be carried on where it is important to secure the observer against changes of temperature.

The aims of a National Physical Laboratory have been well put forward by Dr. Glazebrook in a recent lecture at the Royal Institution, in which he points out how little science has up to the present come to be regarded as a commercial factor in our commercial world. The position of manufacturers of all classes must be helped and improved by a well-considered series of investigations on the properties of materials, measurements of forces, and by the careful standardisation of and granting certificates to measuring apparatus of all classes. Until the question is fairly faced and studied, few manufacturers realise how helpless individual effort or individnal investigations must be when compared with comprehensive and continuous investigations which can be carried on by a National Laboratory so as to deal with the whole of each subject completely and exhaustively, instead of each investigation being limited by the temporary need of each manufacturer or user.

I have already alluded to the verification, care, and maintenance of ordinary standard gauges of accuracy. In this electrical age the accuracy of electric standards is of supreme importance.

Papers, Discussions, &c.

In Section C (chemical) Prof. Frankland's address dealt with the position of British chemical industry at the dawn of the twentieth century.

On Saturday morning the newly formed Educational Section met jointly with the Mathematical Sub-section of Section A to discuss "The Teaching of Mathematics." The discussion was opened by Prof. John Perry, and continued by Major MacMahon, Profs. Rücker, S. P. Thompson, Miall, Minchin and Jamieson, and Sir John Gorst.

"The Buildings of the National Physical Laboratory," by Dr. R. T. Glazebrook, F.R.S. (*Sec. A*)

"The Mechanical Exhibits in the Glasgow Exhibition," by D. H. Morton. (*Sec. G.*)

"On the Use of the Telephone for Investigating the Rhythmic Phenomena in Muscle," by Sir J. Burdon Sanderson. (*Physiolog. Sec.*)

"Report of the Committee on Electrical Standards." (*A.*)

"Note on a Comparison of the Deposits in Silver Voltameters with different Solvents," by S. Skinner. (*A.*)

"On the Conduction of Electricity through Mercury Vapour," by Prof. A. Schuster, F.R.S. (*A.*)

"Sur les Effets Magnétique de la Convection Electrique," by Dr. V. Crémieu. (*A.*)

"On Photo-Electric Cells," by Prof. G. M. Minchin, F.R.S. (*A.*)

"On the Change of Conductivity of Metallic Particles under Cyclic Variations of Electromotive Force," by Prof. J. Chunder Bose. (*A.*)

"Report of the Committee on Resistance of Road Vehicles to Traction." (*G.*)

"Railway Rolling Stock—Present and Future," by N. D. Macdonald. (*G.*)

"Report of the Committee on Radiation in a Magnetic Field." (*A.*)

"A New Gauge for Small Pressures," by Prof. E. W. Morley and C. F. Brush. (*A.*)

"The Laws of Electrolysis of Alkali Salt Vapours," by Dr. H. A. Wilson. (*A.*)

"Preliminary Note on the Theory of the Lippmann Electrometer and Related Phenomena," by F. G. Cottrell. (*A.*)

"Effect of Non-Electrolytes on the Lippmann Electrometer Curve," by J. A. Craw. (*A.*)

Discussion on the Proposed New Unit of Pressure, opened by a Paper by Dr. C. E. Guillaume. (*A.*)

"The Michelson-Morley Effect," by Dr. W. M. Hicks, F.R.S. (*A.*)

"The Law of Radiation," by Dr. J. Larmor, F.R.S. (*A.*)

"The Protection of Public Buildings from Lightning," by Killingworth Hedges. (*G.*)

"The Commercial Importance of Aluminium," by Prof. E. Wilson. (*G.*)

"On a new Electro-magnet and an Echelon Spectroscope for Magneto-optic Observations," by Prof. A. Gray and Dr. W. Stewart. (*A.*)

"On the Nomenclature of the Ions," by Prof. J. Walker, F.R.S. (*Chem. Sec.*)

"Electrolytic Conductivity of Halogen Acid Solutions," by Dr. J. Gibson. (*Chem. Sec.*)

"Economic Effect of the Tramways Act, 1870," by E F. Vesey-Knox, M.A. (*Econ. Sec.*)

Report of the committee on the small screw gauge. (*G.*)

Report of the Committee on the Determination of Magnetic Force on Board Ship. (*A.*)

"On New Instruments for Magnetic Work on Board Ship," by Capt. E. W. Creak, F.R.S. (*A.*)

"The Interference and Polarisation of Electric Waves," by Prof. G. Quincke. (*A.*)

"On the Effects of Magnetisation on the Electrical Conductivity of Iron and Nickel," by G. Barlow. (*A.*)

"The Influence of a Magnetic Field on the Viscosity of Magnetisable Liquids," by Prof. A. Gray, F.R.S. (*A.*)

"The Influence of a Magnetic Field on the Viscosity of Magnetisable Solids," by Prof. A. Gray, F.R.S. (*A.*)

"Stress and Magnetisation of Nickel and Cobalt," by J. W. Peck and R. A. Houstoun. (*A.*)

"Note on the Coherer," by Prof. J. Blyth. (*A.*)

"The Electrolytic Conductivity of Halogen Acid Solutions," by Dr. J. Gibson. (*Chem.*)

Next Year's Meeting.

The B.A. meeting for 1902 is to be held at Belfast under the presidency of Prof. Dewar.

E

CORRESPONDENCE.

On the Training of Engineers.

Your correspondent, "Specialiser," under the heading "How to Kill Technical Education," in your issue of September 6th, draws an analogy between the training of the medical student and that of the engineer. He might, with advantage, have carried it further.

There is practically only one way of becoming a doctor. The medical student, throughout his career, is under the systematic control of the profession. He is subject to a good general training as an essential preliminary to the special training, both being blended throughout with practical work, and the whole being under the direct supervision of men who are acknowledged as leaders of the profession, and who are, for the most part, in daily practice.

The high standard of general excellence of the medical profession is undoubtedly due to the organisation and uniformity of the method of training. Compare this with the chaotic state of engineering training.

Let us suppose that engineering employers discovered that they wanted highly trained engineers.

Before going further I will define a "highly trained engineer" as being, in my opinion, one who has a thorough practical knowledge of that branch of the profession which he is following, together with an equally thorough basis of general scientific training, which enables him to give intelligent appreciation to the work of experts in other branches (chemists, physicists, metallurgists, &c.), at least so far as their work affects his own. Under present conditions, both the time and the money required to obtain such a training will be greater than are required in entering any other profession.

One cannot grumble at the technical college fees, although these are, in most cases, considerably higher for a three years' course than those for the whole of a medical student's course, lasting for five years, and *including his practical training*. In almost all cases our technical colleges are too poor to afford themselves the luxury of entrance examinations—except in name.

Sentimentalism has prompted the squandering of thousands of pounds annually in spreading a thin wash of South Kensington science over the working classes. Concentration of some of this money on a few really adequate scientific colleges, coupled with a thorough system of scholarships for working class apprentices, might produce more tangible results, without injustice.

It is when we come to the practical training that we meet with difficulties. Even "Specialiser" implies that *either* a scientific training, *or* a practical training will make an engineer. I maintain that the one is only useful in conjunction with the other if we are to have engineers trained on a system comparable with that in use in the medical profession.

I will not labour the point further. It is sufficient to point to the action of the Council of the Institution of Civil Engineers on this subject.

I will not now give my reasons for preferring a "pupilage" (by which I mean a real pupilage) to an "apprenticeship" as the means of obtaining the practical part of the training.

"Taking pupils" is a well recognised method of obtaining a more or less handsome increase of income without incurring either responsibility or fatigue. I am well aware that certain firms, notably those with Anglo-American titles, are making considerable changes in this order of things, but this does not upset the general truth of the above proposition. It indicates a state of affairs which has no counterpart in the medical profession.

When engineering employers require highly trained engineers, they will, no doubt, see their way to offering really substantial aid to scientific colleges, by giving free and genuine pupilage to a limited number of those who have acquired a sound scientific training, and who, if they possess good health and business capacity, will form in the end, engineers not to be surpassed by those of any other nation.

Such a course would make it less common for the practical training to be sacrificed to the scientific (or *vice versâ*) than is now the case owing to the heavy cost involved.

We may even yet see the day when those who are always seeing inherent antagonism between practice and theory will cease to weary us with petty quibbles.

Perhaps it will come when we are celebrating the death of the man who has said for the last time that "electricity is still in its ——," but, mindful of the Editor's dread threat, I dare not complete the sentence!

A. K. C. L.

Coal Consumption per Unit in Traction Stations.

Your correspondent's figures are certainly very extraordinary for a steam-driven plant. Perhaps "W. H. J." will tell us what type of machine gives this interesting result; again, is he quite sure that the units he took were the net output of the station, after deducting every electrically-driven auxiliary, and that he has included the coal used by the steam-driven auxiliaries?

W. R.

Fulham, *September 14th*, 1901.

I notice in your current issue a statement as to the coal consumption per unit in traction stations. The figures given by your correspondent "W. H. J." are certainly very good for a 55 per cent. load factor. Prof. Carus-Wilson, the writer of the original article, would also appear to be in possession of the facts of the case. For example, at these works with a "lighting" load factor of 30·0 per cent. (such as was obtained in December, 1900), coal consumption was 5·1 lbs. per unit. Sometimes it has been as low as 4·6 lbs. per unit. In July and August this year we have the following figures:—

Load factor.	Lbs. of coal per KW.
12·3 per cent.	7·35
13·9 "	6·58

The authenticated figure of one of the large Boston stations with a 21 per cent. load factor is 2·9 lbs. per unit.

E. A. T.

Croydon, *September 16th*, 1901.

I notice in your current issue some remarks made by "W. H. J." as to the correctness of Mr. Langdon's figures for coal consumption per unit. I should therefore like to put on record the figures obtained in a small traction station in the Midlands. There are two 200-KW. compound multipolar generators, generating current at from 500 to 550 volts; these are of Messrs. Bruce Peebles & Co.'s well-known manufacture, and are driven by compound double-acting high-speed engines with automatic expansion gear and forced lubrication. The engines run at 350 revolutions per minute, and are made by Messrs. Browett, Lindley and Co., Limited, of Patricroft. The steam pressure is 150 lbs., with 100° superheat. The engines exhaust into surface condensers, but the vacuum when these loads were taken was poor, only 19 in.; therefore the results recorded are nowhere near as good as might be expected if the vacuum was up to the standard of 26 in. There is only one set running at a time, the other acting as a stand-by. For many weeks running the coal per unit has varied from 3·8 to 4·2 lbs., this allowing for all banking of fires, driving of feed pumps, &c., and driving of all auxiliaries, including deep well pumps. I am not aware what size of generating station your correspondent "W. H. J." is in charge of, but should think from the figures it must be of some considerable size. The load factor at the above station is greater, I believe, than the one of 50 to 55 per cent. mentioned by your correspondent; but no matter what size of plant, I consider them to be exceptionally good if they include the total coal divided by the units generated.

Wm. Stead.

Patricroft, *September 17th*, 1901.

Tramway Working: A Suggestion.

The last thing at night, and, no doubt, the first thing in the morning also, there must always be some wayfarers in doubt as to whether the last car has gone, or the first one

near at hand. I suggest that it would be a great public convenience if *every* principal stopping post bore a tablet giving some such information as follows :—

First	car to	X	passes	here at	— a.m.
„	„	Y	„	„	— a.m.
„	„	Z	„	„	— a.m.
Last	„	X	„	„	— p.m.
„	„	Y	„	„	— p.m.
„	„	Z	„	„	— p.m.

Time-tables are never at hand when wanted, and the public memory is proverbially short.

W. Perren Maycock.

Croydon, *September 17th*, 1901.

Apprentice or Pupil.

In reading the letter by "Apprentice" in your last issue, concerning the relative advantages of pupilage and apprenticeship, I noticed several points in which, judging from my own experience, I think your correspondent is mistaken.

With regard to apprentices being shifted into different shops ; it may be the case in the works he mentions, and also in some cases where the apprentice has influence with the masters, but the average apprentice stands a very poor chance compared with the premium pupil. The greater number of firms that take pupils *do* pay them definite wages, and at the works with which I am immediately connected, the pupils are treated exactly as the men as to time-keeping, wages being deducted for all time lost.

Physical hard work does not necessarily mean the best way to learn electrical engineering. A pupil may with advantage spend a portion of his time watching experienced journeymen doing work which he himself is not qualified to do, while an apprentice would soon be called to account by his foreman were he to leave his own work for such a purpose. I may say that I fully believe that the best way to learn electrical engineering, provided that the pupil himself takes an interest in his profession, is a premium pupilage.

Kenneth W. Sutherland.

I am very pleased to see "Apprentice" upholding apprenticeships, as it will give him more impetus to his work in following what he considers the right course of training.

I am afraid your correspondent misjudges me if he thinks I judge a man purely by his monetary affairs ; although the world seems to do so.

Your correspondent falls into the same error for which he blames me, as he thinks a man should have enough money to pay for college training, lecture fees, &c., but according to his argument this should be free ; otherwise it will keep back engineering enterprise, &c.

The comparison between the Army and the industry is no good, as the private has practically no opportunity whatever of entering the officer's ranks. But if a man in an industry or scientific calling shows great ability, he is bound to enter the profession, as Edison and Faraday did. The question is, what do we gain by admitting men into the profession without their being put to any expense ? We certainly lower the tone of it, and let a lot of ordinary talented men in to glut the market ; for by his own argument, what sort of man will he be who has to be driven to work in the following way ? :—

1. *Has* to keep regular hours, including regular early morning rising, the latter to my mind interfering with the evening studies through fatigue of the long day's work.
2. He is *made to work hard*.
3. Wants a *stimulus in the form of money* to help him to learn his business.

I think this man would do well to read Dr. Perry's inaugural address to the electrical engineers last year, which bears well on this point.

Fiat Justitia.

Maximum Traction Swivelling Trucks.

As many of the modern electric tramcars running in this country are mounted upon swivelling trucks of the maximum traction type, I should be very glad to learn from your correspondents who have had experience of their working as to whether they have found the trucks in general use to be satisfactory.

I have lately been engaged upon the construction of an electric tramway, or, perhaps, I should say light railway, as it runs through the fields, and am sorry to state that my experience of the trucks in use has been very unfortunate. There have been many and frequent derailments.

The permanent way is of a very strong description ; the curves, of which there are two, have a uniform radius of 300 ft., with 200 ft. radius at turnouts, it being a single line.

The permanent way was laid with the greatest care, suitable cant being given to all curves, with a slight slackness of gauge.

The cars are mounted upon two "maximum traction" trucks, having a fixed wheel base of only 4 ft., the gauge of tramway being considerably more. The driving wheels of truck are at either end, whilst the smaller ones face towards the centre of the car. The designers, I believe, maintain that although a small percentage of the dead load is borne by these small wheels whilst travelling upon the straight track, this load is automatically increased when passing around a curve, so as to prevent derailment. In many cases this does not have the desired effect.

The great majority of derailments that have occurred under my notice are caused by the little wheel of trailing truck mounting the outer rail, sometimes dragging the driving wheels off as well. The peculiar part is, that in some cases the car takes the curve quite readily, but leaves the rails upon reaching the straight road. This appears to me as if the trucks partially jammed whilst traversing the curve and failed to correct themselves on finding the straight.

I have no doubt many of your readers have had trouble with similar trucks, and a general ventilation of the subject would, I am sure, be welcomed by electric traction engineers throughout the country.

Inquirer.

Bogie Car Design.

There is a mechanical point in connection with the high-speed electric car described by Herr Lasche which may, perhaps, be mentioned. The bogies are six-wheeled, but only four of the wheels are driven. Let the remaining axle be removed from each bogie, and let both be brought to the centre of the car and then fixed while the flanges of their wheels are removed. We shall now have *three* points of support for the car, a four-wheeled bogie at each end and a fixed one (so to say) at the middle. This will enable us to lengthen the car considerably, and so carry more passengers. Engineers seem to forget sometimes that it is not necessary to construct a railway carriage like a girder bridge, as there is nothing to prevent the introduction of supporting wheels at the middle of the span.

Alfred J. Allen.

London Institution, E.C.,
September 16th.

The Rating and Testing of Electrical Machinery.

With reference to the abstract of the paper by Mr. Gisbert Kapp on "The Rating and Testing of Electrical Machinery," read at Glasgow, appearing in the Electrical Review of the 13th inst., I note that in paragraphs 18 and 19 of the appendix, the figures for temperature rise given in degrees Fahr. do not agree with the rise given in degrees Cent., evidently through a clerical error.

For instance, a rise of 50° C. equals a rise of 90° F., and not 122° F. as given, as 35° C. air temperature plus 50° C. rise equals 85° C., which equals 185° on the Fahr. scale, and which less 95° F. air temperature gives 90° F. rise.

In the same manner all the temperature rises given in degrees Fahr. are 32° too high.

I venture to raise this matter, as the figures may cause errors unless attention is drawn to them.

G. W. Money.

[We reprinted Mr. Kapp's paper in full, not in abstract. The discrepancies to which our correspondent refers did not

escape us, but we concluded at the time that the inacccuracy lay, not in the figures, but in the use of the expression "temperature rise." The values must refer to the *final* temperatures, otherwise we should have such abnormal temperatures as 125° C. in stationary windings authorised by the German Association, corresponding with an increased resistance over 40 per cent. above that at normal temperature. Such a value would be quite incompatible with high efficiency, durability and self-regulation, and we cannot believe that the actual *rise* was meant.

As a matter of fact, we made one alteration, where a *difference* of 10° C. was given as 50° F., by an obvious error; the rest of the figures are exactly as given in the paper.—Eds. Elec. Rev.]

A British Polyphase Installation.

The last paragraph but one of this article in your issue of September 6th might lead it to be inferred that the wiring was undertaken by ourselves. In justice to the contractors for this part of the work, Messrs. Thos. Laurie & Co., of Falkirk, we should like to correct this impression. The wiring was quite a separate contract from the polyphase power plant, the lighting plant, switchboards, motors, &c.

The General Electric Company (1900), Limited.

Manchester Switchboards.

With reference to your report in current issue regarding above, you mention that "A well-known engineer had told him (Dr. Bishop) that on revising his tender (which was sent out in his absence from home) he found that he would have been able to do the work for £35,000;" and "this discovery had made the engineer determined on a thorough reorganisation of his switchboard staff."

This seems to bear out the Continental view that the British manufacturer is always "unready." I think the engineer referred to above belongs to the numerous class who do not recognise that it is necessary to pay for accuracy. The estimating, although the vital portion of their business, does not receive enough attention. Had the above tender been drawn up by a thoroughly competent man, it would not have made any difference whether the engineer was at home or not at home.

The fact, however, of his going away and allowing important tenders to be got out by people in whom he apparently had little confidence (hence the revision on his return) shows that the engineer himself has a serious lack of business ability. I would not be astonished to hear next that "he now finds that, having forgotten to multiply by $\sqrt{3}$, his original tender was quite correct."

Anyway, his "discovery," and consequent tragic wail, afforded me an opportunity for a quiet snigger, which I have no doubt was also enjoyed by many of your readers. It is not often one gets such opportunities nowadays, and I beg to thank the engineer referred to for it.

Three-Phase.

BUSINESS NOTES.

Boiler Feed Pump Tests.—Referring to the tests made by Mr. J. R. Blaikie on Messrs. J. P. Hall & Sons' compound feed pump, a regrettable mistake occurred in our Note last week, inasmuch as, in deducing the pounds of steam used per H.P.-hour, the value at full speed was omitted. The steam consumption per H.P.-hour, in fact, was

At 35 strokes per minute	...	...	...	49 lbs.
„ 25 „ „	...	...	...	57 „
„ 16 „ „	...	...	...	67 „

It will be seen that with this correction the pump makes even a better showing than before.

Claim for Injuries.—At the Brompton County Court on Monday the Westminster Electric Supply Corporation, Limited, had a verdict given against them in favour of a newsagent upon whom their workmen in May last allowed a pole, with which they were hoisting an electric light standard, to fall, his right shoulder and arm being injured. Damages for personal injuries were awarded by the jury to the tune of £20, and judgment was given accordingly with costs.

Electrical Wares Exported.

Week ending Sept. 18th, 1900.		Week ending Sept. 17th, 1901.	
Adelaide	£75	Aden. Teleg. mat.	£56
Alexandria	170	Amsterdam	185
Amsterdam	100	Beira. Teleg. mat.	103
Auckland	161	Bombay	49
Bombay	169	Brussels	120
Brisbane	20	Buenos Ayres	619
Buenos Ayres	867	„ „ Teleg. cable	744
Calcutta	244	„ „ Teleg. mat.	105
Cape Town	638	Calcutta	4,324
Colombo	68	„ Teleg. wire	208
Copenhagen. Teleg. wire	61	Cape Town	2,786
Durban	774	„ Teleg. instruments	695
„ Teleg. apparatus	442	Chinde	96
Emden. Teleg. apparatus	308	„ Teleg. cable	511
Essen. Teleg. mat.	60	Christiania	177
Flushing	28	„ Teleg. wire	70
Gibraltar	20	Colombo	55
Hamburg. Teleg. mat.	200	Copenhagen. Teleg. wire	56
Hong Kong	102	Delagoa Bay	40
Launceston	85	Durban	515
Lyttleton	158	East London	48
Malta	32	„ Teleg. mat.	231
Mauritius	30	Hamburg. Teleg mat.	200
Melbourne	1,218	Hong Kong	21
„ Teleg. mat.	994	Karachi. Teleg. mat.	665
Ostend	300	Lyttleton	85
Rotterdam. Teleg. wire	74	Melbourne	131
Shanghai	165	Port Elizabeth	17
Singapore	33	Rio Janeiro	68
Sydney	675	Rosario	45
„ Teleg. mat.	624	Rotterdam. Teleg. wire	19
Trieste	365	Shanghai	151
Wellington	2,467	Singapore	72
„ Teleg mat.	4,180	Stockholm. Teleg. wire	76
Yokohama	408	Sydney	486
„ Teleg. cable	13,284	Tokio	136
		Wellington	88
		Yokohama	709
Total	£29,048	Total	£14,712

Foreign Goods Transhipped.

Perth. Teleg. wire	£215	Calcutta. Elec parts	£64
		Durban. Teleph. wire	76
		Perth. Elec supplies	35
Total	£215	Total	£175

Austria.—A dividend of 7 per cent. has been declared by the Austrian Schuckert Company, of Vienna, for the last financial year.

Bankruptcy Proceedings.—On 27th inst., in *re* T. M. Campbell & Co., electrical engineers, 46½, Clyde Place, Glasgow, Mrs. Margaret Russell or Campbell, 11, Shields Road, Glasgow, sole partner of said firm, is to be examined in the chambers of Sheriff-Substitute Mr. Boyd, County Buildings, Glasgow.

Dissolution.—Messrs. H. Patterson & C. R. Whipple (Patterson & Whipple, electrical and mechanical engineers, Moorfields and Edmund Street, Liverpool) have dissolved partnership. Mr. Patterson continues the business and attends to debts.

The Berlin Fire Exhibition—a Loss.—Reuter says that the International Exhibition at Berlin of appliances for protection against fire has closed with a deficit of 400,000 marks, of which 230,000 are covered by the guaranteed capital.

Brill Cars to be Made in England.—It is stated in a Yorkshire paper that the Brill Car Company, of Philadelphia, announces its intention to invade the home markets of England, and erect a plant on a site not yet definitely selected. "The company will not at present build any passenger cars, but will accept orders for goods cars and coal trucks."

Catalogues and Lists.—"The Industrial Applications of Electricity" is the title of a brochure which has been issued by the B.T.H. Company illustrating various plants from which they have supplied motors and electric driving equipments. Iron-working, wood-working, coal-transporting, printing and other machinery is shown.

Messrs. L. Kamm & Co., of Powell Street, Goswell Road, E.C., send us a small, but neat, catalogue of their Kammatograph patent accessories and specialities. Hand-feed arc lamps, "electric" plant projecting lanterns, rheostats, and other electrical things are illustrated and priced.

We have received from the Electrical Trades Supply, Limited, of Cornwall Street, Birmingham, a few of their illustrated sheets of electrical accessories which they are introducing. They include Treppman's patent universal clawed dowels for electrical installations, H.V. tumbler switches, single-pole cut-outs, ceiling roses, counterweight sets, and electric fans.

The Sunbeam Lamp Company, Limited, has sent us a very neat little pocket list of its well-known incandescent lamps.

Messrs. Aston & Mander, of Old Compton Street, W., send us a list of their mathematical and drawing instruments.

Pamphlet No. 110 of the B.T.H Company describes the G.E.—800 traction motor.

City of London College.—The Michaelmas term commences on 30th inst. See advertisement pages to-day.

Fires.—Among fires officially reported in London on Sunday was one at 13, Carlton House Terrace, S.W., where a defective circuit of the electric wires caused a small fire in the back basement of the residence of Sir E. Durning-Lawrence, M.P.; and at Beardell Street, Norwood, where a defective electric light circuit

caused a fire on the premises of the Crystal Palace District Electric Supply Company, Limited.

We read that a destructive fire broke out in the early hours of Tuesday morning at Enderby's Wharf, East Greenwich, on the premises of the Telegraph Construction and Maintenance Company, Limited. A building extending 130 ft. in one direction and 60 ft. in another, and used as engineers' workshops, pattern room, and stores, was entirely destroyed, and other serious damage was done.

Foreign Electric Plant Imports.—August proved to be a quiet month as regards the imports of foreign electrical goods and apparatus into this country, the returns showing a total of only £42,096, as compared with £42,107 in the previous month and £148,317 in August, 1900. To the end of August last the value of such imports had only amounted to £637,169, as contrasted with £697,592 in the first eight months of 1900.

Nernst Lamps for Street Lighting.—We are informed that the Prism Globe Company, Limited, are supplying to the Urban District Council of Shipley, Yorkshire, a number of their two-light swan-neck brackets and fittings, each adapted to carry two 40-watt "Nernst" lamps. This is believed to be the first instance in England where "Nernst" lamps will be employed for public street lighting. The work is being carried out to the specification of Mr. R. C. Quin.

Northern Polytechnic Institute.—From Principal R. T. Smith we have received a copy of the prospectus of this Holloway Institute for the 1901—1902 session. Mr. V. A. Mundella, M.A., B.Sc., is lecturer in the electrical engineering sections.

Polytechnic Classes. — The electrical engineering, wiring, and technical mathematical classes at the South-Western Polytechnic recommence for the new session on 23rd and 30th insts. See our advertisement pages.

Schmidt Superheaters.—The Oakbank Oil Company, of Glasgow, have placed a contract with Messrs. Easton & Co., Ltd., for two Schmidt patent superheaters of the direct fired type.

Street Sweeper.—The Dundee cleansing department has introduced a combined electric sweeper and sprinkler.

Trade Announcements.—Messrs. Handley & Shanks, of Birmingham, have appointed Mr. J. W. Garsden as manager of their Manchester branch, and all inquiries sent to 46, Corn Exchange Buildings, Fennel Street, Manchester, will meet with immediate and prompt attention.

We are informed by Mr. Braulik that the agency which he has held for the past ten years for Messrs. Koerting & Mathiesen's arc lamps terminated on the 4th of the present month. This, however, does not justify the inference that Mr. Braulik no longer supplies arc lamps. On the contrary, he informs us that he will in future supply lamps of standard quality, English make, to meet all requirements.

The office of the Westinghouse Company, Limited, electric department at St. Petersburg has been removed from the Great Morskaia to Nevsky Prospect No. 11, St. Petersburg.

Wolverhampton Exhibition.—In connection with this exhibition, the preparations for which are now making rapid progress, it may be worth noting that the whole of the machinery exhibits will be driven by electricity, which will also be used for lighting the building throughout. The Exhibition Committee are now inviting tenders for the erection of the machinery hall; the contract for the industrial hall has been already let.

ELECTRIC LIGHT AND POWER NOTES.

Barnstaple.—An inquiry will be held by the L.G.B. on September 26th into the application of the T.C. for leave to borrow £27,000 for electric lighting purposes.

Bedford.—In continuation of our note of last week, we learns that Mr. Bock's committee "having induced him to stop at West Ham," and making it "against his interest" to go to Bedford, he has declined the appointment with regret at having given unnecessary trouble. The matter has accordingly gone back to committee to select more candidates, and Mr. Hope Johnstone has been asked to continue the work for a month or so longer.

Bradford.—On Friday last the foundation stones of the new generating station of the electricity department of the Corporation, which is being erected in Valley Road, were laid by Councillors T. H. Shaw and J. Akam, the chairman and deputy-chairman of the Electricity Committee. The chairman said the Electricity Committee had increased in importance within the last few years more rapidly than any other in Bradford, and quoted figures to show the progress made since 1889, when it was formed. In that year the total capital expended was £18,456, while in 1900 it was £280,469. Since he had been appointed chairman they had obtained powers for £210,000, part of which was for that building. In 1900 the number of units supplied had increased to 3,424,658, and the number of consumers amounted to 1,277, with 172,641 lamps connected. These figures were sufficient evidence of the gigantic work which the electricity department were now doing. Electricity was superseding every other form of motive power in Bradford, and it was being used by every trade; such indeed was the demand, that the Committee scarcely knew how to meet it. The new works are adjacent to the second generating station erected by the Corporation, and are so arranged, that they can readily be doubled in size. The first instalment of plant will be of 6,000 H.P.; the engines are being built by Messrs. Cole, Marchent & Morley, Limited, of Bradford, and the generators, each of 1,000 KW., by the British Westinghouse Company, Limited. A cooling tower is being erected for condensing purposes. The total capacity of the station, when completed, will be 20,000 H.P. Water-tube boilers, with mechanical stokers and superheaters, will be installed, and a coal store of 2,000 tons capacity will be provided, with a complete coal-handling plant. At a luncheon of the Committee and staff on the same day, replying to a toast, Mr. R. A. Chattock, the city electrical engineer, stated that the equipment of the new works would not be surpassed by that of any station in Britain.

The Corporation has resolved that the salary of Mr. R. A. Chattock, city electrical engineer, should be advanced by £100 per annum from July last and £100 from July next. The former salary was £500.

Brighton.—The T.C. has informed the Clayton Parish Council, in reply to an inquiry, that it would be willing to consider the question of supplying Clayton and other parishes with electricity in bulk.

Chatham.—The Chatham and District Electric Light Company has given notice of an advance in the price of electrical energy from 4½d. to 5½d. per unit.

Colliery Lighting.—The Bridgewater Trustees, near Manchester, have just had an electrical installation put down for use at the bottom of the shaft of their collieries. It is stated that numerous colliery proprietors in South Lancashire are following their example.

Coventry.—In the June quarter the receipts of the electric lighting department went up from £669 in the corresponding period of 1900, to £945, the number of consumers from 277 to 341, and the units sold from, roughly speaking, 45,000 to 57,000. These figures should bring hope to the minds of those who imagine, from what has hitherto happened, that the undertaking will always be a dead loss.

Dumbarton.—The T.C. has resolved to apply to the B. of T. for a prov. order for electric lighting. The Provost said they wanted to be in the position that if the Clyde Valley Company came into the town, the Council was to be the authorised distributor of the electricity.

Dundee (S.A.).—The Dundee Electric Power Company has been formed recently to light up the town.

Esher.—The U.D.C. declines to consent to the application of the Provincial Electric Supply and Traction Company for a lighting order for the district.

Falkirk.—The Committee on Electric Lighting recently reported that it had been met by Mr. Hawtayne, consulting engineer, who had given general information on the subject, and that it had visited a number of towns in Scotland where the electric light had been adopted. It was decided to get the opinion of Messrs. Burstall & Monkhouse as to cost, &c., and to make inquiries as to the terms of private companies.

Glasgow.—The statement of accounts, &c., for the year ending May 31st, 1901, shows the following results:—Gross revenue, £79,449 14s. 11d.; working expenditure, £46,647 4s. 11d.; interest on loans, £24,547 4s. 3d; sinking fund, £8,662 19s. 4d.; proportion of cost in supplying lamps, &c, to consumers consequent on change of voltage, £4,109 13s. 4d.—total, £83,967 1s. 10d.; leaving a deficit of £4,517 6s. 11d., which has been drawn from the reserve fund. The total cost during the last three years consequent upon the change of voltage from 100 to 250 volts has amounted to £13,847 9s. 3d., part of which has been cleared off as above, the remainder, £9,737 15s. 11d., being placed to a suspense account to be cleared in four years.

Linthwaite.—The D.C. has decided to ask the Slaithwaite and Golcar Councils to arrange a meeting with this Council to consider the question of electric lighting in the district.

London.—BATTERSEA.—Arrangements are being made for the new electric light generating station in Lombard Road to be formally opened on Saturday, the 28th inst. At present the authorised expenditure in connection with the electric lighting undertaking has, up to September 3rd, amounted to £152,182. Of this sum, however, £23,835 represents additional expenditure incurred since the presentation of the original estimates. The amount of loan taken up is £125,483. The contemplated expenditure in respect of arc lamps and posts for public lighting is £5,107.

The Borough Council have appointed Mr. E. G. Bergersen, the engineer of the Town Hall lighting station, to be the second assistant engineer at the central electric generating station.

FULHAM.—The Board of Guardians has resolved to provide an installation for the electric lighting of the workhouse, infirmary, and board offices of the parish at a cost not exceeding £11,111. Mr. Medhurst was instructed to prepare the necessary specifications of works, plans, and forms of tender. It was stated that it would be cheaper for the Guardians to generate their own current than to take it from the Borough Council.

SOUTHWARK.—The Borough Council on Wednesday had before it a resolution to make application to the B. of T. for a prov. order to supply electricity within so much of the Borough of Southwark as

is not comprised in the Council's area of supply under the Newington Electric Lighting Order, 1897.

Notice has also been served by the City of London Electric Lighting Company, who possess an Order for St. Saviour's, and by the County of London and Brush Provincial Electric Lighting Company, who possess an Order for St. George-the-Martyr, of their intention to apply for authority to supply energy throughout the whole of the borough. The Council intends to oppose these applications.

Londonderry.—At a special meeting of the Corporation last week the project for the electric lighting of the city was considered. Sir W. H. Preece's plans were submitted, from which it appeared that the scheme would cost £35,000. After a lengthened discussion, the meeting adjourned pending the receipt of another report from Sir William Preece.

Manchester.—The Corporation has been summoned for failing to supply electricity when requested by Mr. S. Howard. The information laid against the Corporation was that they had, on August 12th this year, and every subsequent day, failed to maintain through the distributing main in Oldham Street a supply of electricity of sufficient power for the use of all the consumers entitled to be supplied through that main; that the complainant applied on August 9th this year for a supply of electricity to his premises, 143, Oldham Street, and that he had been deprived of such electrical energy, suffering in consequence serious loss and damage to his trade. When Mr. Howard purchased the premises from the former tenant he took over the electrical fittings also; but he found, on occupying the premises, that the electricity officials had taken away the meter. In the windows of Mr. Howard's shop there were some large show cases lighted by electricity, and if the energy were not supplied it would involve Mr. Howard in very great expense in restoring the gas fittings. It was submitted that under the Corporation Act, 1890, the prosecutor was entitled to a supply of electricity. On August 9th Mr. Howard wrote to the electrical department of the Manchester Corporation asking them to forward him a form of application for the supply of electric current to his new premises, but nothing was done, and eventually the action was brought. The defence was set up that there was, as a matter of fact, no application for a supply on the 9th. It was merely a request for a form. The letter did not name the day on which the supply was to commence, and, therefore, the complainant failed to comply with the conditions laid down in Section 21 of the Order of 1890.

Mr. Rycroft, who appeared for the complainant, said he was surprised at the Corporation setting up such a shabby defence—a mere technical defence—because they were not fulfilling their public obligations. Unless the Corporation would undertake to supply his client that day they would certainly appear in Court again, and next time they would be in order. He asked that the summons should be dismissed, and this was done.

The local press has had various leading articles, of a more or less sarcastic tone, on the subject.

A Manchester contemporary says, in view of the dark days, some curiosity is naturally felt with regard to the supply of electric light and power in the city. For some considerable time Dickinson Street has been working at full pressure, but it is hoped that by the end of October the Bloom Street works will contribute, as a first instalment, an additional horse-power of 3,500. Should all go well, the first two Stuart Street sets may be at work by next May. With the completion of the Bloom Street works to supply 14,000 H.P., and Stuart Street with 15,000, there will be ample power for all purposes.

Maritzburg.—A Bill is before the Natal Parliament to authorise the Borough Council to borrow the sum of £150,000 sterling, for the purpose of refunding to the Borough Improvement Loan Fund certain moneys utilised for the installation of an electric lighting system for a portion of Maritzburg, and of extending the system within the borough.

Melton Mowbray.—The lighting of the main thoroughfares by arc lamps was successfully inaugurated on Tuesday last.

Perth (W.A.).—The Perth Gas Company have reduced their prices for electricity 1d. per unit, making it 8d., 7d., and 6d. for lighting, and 6d., 5d., and 4d. for motive power net. Some £2,000 worth of additional machinery was recently installed, and the company's electrical engineer (Mr. H. Broadbent) has come to England to purchase £10,000 worth more.

Richmond (Surrey).—Mr. Dykes (of Messrs. Handcock and Dykes) has been appointed by the Corporation to inspect the new cables now being laid by the Electric Light and Power Company.

River Plate.—The *Review of the River Plate* says that the new electric light station in Mendoza will commence to supply current this month.

Rochester.—As the result of a recent interview with Mr. Jasper, upon the subject of the purchase by the Corporation of so much of the Chatham Electric Light Company's undertaking as affects the city, it was resolved that the offer of the Corporation be increased from £3,000 to £5,000.

St. Helens.—The annual statement of accounts of the borough shows that the capital expenditure on the electric lighting account has been £100,175 12s. 9d., and on the tramways £118,074 11s. 11d., the total expenditure being £218,250 4s. 8d. The tramways account shows a balance to credit of revenue account of only £213 13s. 10d., out of which charges for repairs have to be paid.

Salford.—The result of the year's working of the electricity department is, notwithstanding an increased income of £1,252 3s. 1d., a deficiency of £7,489 8s. 7d., as against a deficiency of £2,028 5s. 7d. in the previous year. The principal items of increase appear to be—cost of generation, £2,950 12s. 11d., of which sum coal and coke are responsible for an increase of £2,490 19s. 3d.; distribution (change of voltage, £920 4s.), £1,200 17s. 9d.; and interest and contribution to sinking fund, £2,233 4s. 9d. The electric lighting works commenced supply in August, 1894, and since that date there has been a total deficiency of upwards of £20,000. The whole of this deficiency has been met by the rates.

Shrewsbury.—On Friday last Mr. H. P. Boulnois, M.I.C.E., held an inquiry on behalf of the L.G.B. respecting an application by the T.C. for a loan of £16,526 for electric lighting purposes. In October, 1898, the Corporation applied for a loan of £35,800 to purchase the Shropshire Electric Lighting Company's works. Sanction was obtained for this sum except £3,011, which the Board withheld pending further inquiries. Since entering into possession of the undertaking the Corporation had made considerable additions. Further extensions to the works had been found necessary, and hence the present application. The borough electrical engineer, Mr. C. M. Johnson, gave evidence. There was no opposition to the application.

Southampton.—A dispute between the Guardians and the Electricity Committee of the T.C. in reference to the assessment of the electric power station, with the mains, has been settled by a compromise. The amount of the assessment has now been fixed at £1,750.

Southport.—The Southport electrical engineer's report for the past year shows that the surplus is £700 less than the estimate, and the actual financial result is a deficit of about £800, towards which there is a sum of £280 brought forward from the previous year, leaving on the electricity account a net deficit of £520 odd. The gross profit for the year is £7,292, against £6,384. The total working costs have increased from 1·60d. to 1·65d. per unit sold. Management has decreased from ·34 to ·25, and Sheffield is the only town which gets the management costs down to a lower figure. The units sold to ordinary customers have advanced from 607,002 to 731,777, an increase of 20 per cent. The report was confirmed at a meeting of the Southport Town Council on Tuesday evening, at which it was decided that the wages of Mr. A. S. Black, assistant electrical engineer, be increased from £3 to £3 10s. per week, and that the wages of Messrs. W. Green, W. Legge, and P. Anley, electricians-in-charge, be also increased.

Stourport.—The U.D.C. is considering whether to undertake the work of electricity supply, or to confer its powers upon the Electric Traction Company.

Sunderland.—A warm debate took place at the meeting of the Council on 11th inst. as to the disposal of the profits accruing from the electric light undertaking. It was resolved that the £1,257, the balance on the past half-year, should be carried forward to March 31st, when the Committee should be required to repay to the Finance Committee £1,849, the balance due still in regard to the amount drawn from the rates. By the time that the £1,849 is due, it is estimated that there will be a balance to the credit of the Lighting Committee of about £4,000.

The Council proposes to apply for sanction to borrow £30,000, partly for the new electricity station in Hylton Road and partly for the existing station in Dunning Street. The scheme includes £7,673 for the extension of mains and over £12,000 for future extensions.

Thames Ditton.—The D.C. has received notice from the Provincial Electric Supply and Traction Company of their intention to apply for a prov. order to supply electricity in the district. The Council will not consent to the application.

Thornaby.—The T.C. has resolved to apply to the B. of T. for a prov. order to supply electricity within the borough.

Walsall.—The T.C. has decided that the scale of charges for electrical energy for lighting purposes be amended by reducing the number of hours the maximum load shall be charged for at 6d. per unit from 273 to 230 in each half-year, which will represent striking off one hour and a half for each Sunday, Bank Holiday, Christmas Day, and Good Friday. It is estimated that this will involve a loss of revenue to the extent of £300 a year. The scale of charges for motive power was also amended by reducing the number of hours during which the charge of 2½d. per unit shall be made from 300 to 200 per quarter. All units above the last-mentioned quantity will be charged at 1d. per unit. The electric mains are to be extended at an estimated cost of £1,700.

Willesden.—A public inquiry was held last week by Mr. H. H. Law, L.G.B. inspector, into the application of the D.C. for power to borrow £143,000 for electric lighting purposes. The prov. order was obtained in 1898, and sites for a generating station and a sub-station were purchased last year. The evidence showed that new houses in the district were being wired from the start, and the need of an electricity supply was very marked. The initial equipment is intended to be of 1,000 KW.

Worksop.—The formal opening of the electricity works was to take place on Tuesday last. One of the engines broke down on Sunday evening, but the plant is in duplicate, so that no delay was caused by the accident.

Worthing.—The electric light installation will be formally inaugurated to-morrow by the Marquis of Abergavenny, K.C.

ELECTRIC TRACTION NOTES.

Aberdeen.—The Tramways Committee decided last week to get a report from the burgh surveyor and the electrical engineer in connection with the proposed electrical equipment of Union Street route, as to the advisability of erecting overhead wires with rosettes attached to the buildings, as a temporary expedient, so as to form a connection between the Mannofield and Sea Beach routes.

Bondi, N.S.W.—The Railway Commissioners have been considering the extension of the electric tramway system to Bondi, thus serving Paddington, Waverley, Woollahra, and other centres.

Cardiff.—A discussion which occurred at last Tramways Committee meeting showed that members are becoming impatient at the delay in the completion of the tramways service.

Central London Railway.—The *Times* says that the final official inspection of the special train, and the two improved locomotives, which have been constructed for the Central London Railway for the diminution of surface vibration above the route of the line, took place early on Sunday morning, when Mr. Mallock, the technical adviser to the Vibration Committee, made a special series of observations. He is understood to have quite satisfied himself that the remedy for vibration has been found.

Croydon.—It is anticipated that the electric tramway system of the British Electric Traction Company will be opened within the next fortnight. The company contemplate extensions of their lines through Mitcham to Wimbledon.

Epsom.—Mr. J. Clifton Robinson, managing director of the London United Tramways, Limited, attended the last meeting of the R.D.C. with reference to the company's proposal to construct the following lines of electric light railways:—

1. A line from Epsom to Wimbledon, along the main road, through Ewell, Morden and Merton.
2. A line from Surbiton to Croydon, through Ewell, Cuddington, Cheam, Sutton and Carshalton.
3. A line from Epsom to Ewell, and
4. A line from Hook to Leatherhead through Chessington.

The whole subject was referred to a committee.

Esher and the Dittons.—In connection with the London United Tramways' proposed extension in rural Surrey, the U.D.C., at last week's meeting, considered the plans for about four miles of new tramway route affecting their district.

Felling.—The U.D.C. last week heard letters read offering terms for electric lighting and additional tramways from the following companies, viz., Electric Power Distribution Company, Limited, Northern Counties Electricity Supply Company, Limited, United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited. The Council decided to refer the matter back again to Committee.

Glamorgan.—The County Council has a scheme for running electric cars to various places, the cost being put down at £600,000, but Merthyr kicks at the proposal, it already having an electric car service.

Greece.—Mr. F. W. Jackson, United States Consul at Patras, Greece, says that the progress of communication within Greece at present is marked and promises in the near future to bring conveniences of travel to a level with those of any country in Europe. The Greek Electric Company, otherwise known as the Thomson-Houston Company, established in 1898, with a capital stock of 10,000,000 drachmas ($1,250,000) of which 5,000,000 drachmas ($625,000) is paid up, is now completing in Patras the first electric street railway in Greece. The same company operates the gas company of Patras, the electric light plants of Athens and Piræus, and of four or more other cities, and is now negotiating with the Athens-Piræus Street Railway Company to supply motive power from a central electric station at Phalerum, near Athens. This proposed power station, if constructed, will be on a scale sufficiently large to supply power for manufacturing purposes, as well as for the lighting of Athens, Piræus and Phalerum. Speaking more particularly of the street railway in Patras, the system will be similar to that found in general use in France and Italy. The motive power will be furnished by gas engines of German construction. The steel rails are from Belgium, while from the United States there will come—from the General Electric Company—the material for the aerial line, insulators and car motors, and—from the Brill Company—the trucks for the cars. The main stem of the road is constructed the length of the city, parallel with the sea, and extends some distance beyond the city limits, to a point suitable for coffee houses and baths.

Grimsby.—The electric tramways are gradually approaching completion, and several trials have already taken place. The other day current was switched on from the Corporation electric station, and a car was run over the entire length. Those on the car during the trial were Mr. J. Glenn, of London, engineer to the Tramway Company, Mr. J. F. Glenn, resident engineer, Mr. J. R. Glenn, Mr. A. Daniel, chief of the electrical department for the contractors (Messrs. Dick, Kerr & Co.), also the representatives of other contractors. As soon as the portion of the track at the Dock railway gates is re-laid, the system will be ready for permanent use. The work of erecting the power station of the company in Pelham Road, Cleethorpes, is practically completed, and the engines were started on Thursday last week. An inspection was to have been made on Tuesday, September 10th, by the Board of Trade, but a postponement has been made to a date not yet fixed.

India.—Our New York namesake says that a scheme is on foot for introducing electric traction in the Baroda State, in India. It is proposed to construct a tramway from Chilal to Amreli and Challala, and to work the same by electrical power, to be generated by harnessing the Khovia and Matta falls of the Shetranji River. The project is at present under consideration by Mr. Graham R. Lynn, M.I.C.E., chief engineer to the Dubar, who, it is said, was much struck with the possibilities of electric locomotion during his recent visit to England and the Continent. A draft order has been issued authorising the construction of tramways in the town of Mandalay also. The order has been obtained by the Burma Electric Works Syndicate, which is empowered to carry out the scheme.

Isle of Man.—Last week Sir James Gell, Manx Clerk of the Rolls, opened the tenders for the Isle of Man tramways. There were four offers. The highest for the whole concern, namely, electric, horse, and cable sections, was from the British Electric Traction Company, who bid £225,000. The next was £210,000, offered by Messrs. H. Kidson & Co., Manchester. The highest offer for the electrical sections separately was £188,850 by Mr. Harold Vickers, and the highest for the horse and cable sections only £40,000, by Douglas Corporation. The last two combined, therefore, are the highest bids, namely, £228,850. The opinion is expressed, says the *Liverpool Mercury*, that none of the tenders will be accepted. The company has debentures to the extent of £175,000, and there is also the shareholders' capital involved, amounting to £150,000.

Johnstone.—The Council is inquiring of Mr. Murphy when he intends to proceed with the electric tramways for the borough.

Kingston and Surbiton.—The L.U.T. have temporarily abandoned their proposed extension to connect Kingston with Wimbledon direct *vid* Coombe Hill, but will proceed with the alternative route from the authorised terminus at New Malden, along Burlington Road, through Raynes Park to Wimbledon. There is also a scheme to connect Surbiton with Croydon, from the termination of the authorised line at Tolworth, and passing through Ewell, Epsom and Sutton.

Leatherhead.—The L.U.T. has informed the U.D.C. that its proposed tramway extensions to Leatherhead will be in abeyance at present.

Liverpool.—From the statements made last week by Alderman Petrie, chairman of the Tramways Committee, Alderman Smith and Councillor E. L. Lloyd, during the discussion, it appeared that Mr. McCullough had patented certain electrical appliances and disposed of these patents or entered into an agreement with respect to them with firms who were on the list of Corporation contractors. Alderman Petrie had had an interview with Mr. McCullough with regard to these transactions, pointing out that from the point of view of the Committee, Mr. McCullough had placed himself in a serious position by entering into the agreement with a particular contracting firm, as it was an agreement described by the deputy town clerk as practically a partnership agreement, and it was the practice of the Council never to have any of its officials connected with any trade concern. Mr. McCullough had expressed regret that he had entered into the agreement, saying that he had not seen that he was doing any harm, and was, therefore, willing to cancel the agreement with the firm. At a later date, during Mr. Petrie's absence from Liverpool, Mr. McCullough was asked by the Committee to resign. Several questions respecting fittings and materials for the cars had also arisen, and through these questions the relationship between Mr. McCullough and the Committee became strained. This fact, and the circumstances of Mr. McCullough's dealings with his patents, led the Committee to ask him to resign, as stated in our columns.

On Mr. McCullough's behalf, Messrs. Simpson, North & Co., solicitors, wrote to the Town Clerk, stating that their client desired to have an opportunity of meeting charges made against him, and asking if the Council were prepared to grant the inquiry which he asked for.

During the discussion at the Council meeting, Mr. Utley moved an amendment that a special committee consisting of all the members of the Council be appointed to consider the circumstances of Mr. McCullough's dismissal. The amendment was seconded, and a long and animated debate followed. Eventually a vote was taken, when 16 voted for the inquiry and 54 against. The amendment was therefore lost.

Mersey Railway.—The report of the directors of the Mersey Railway Company for the half-year ended June 30th last says that an agreement has been entered into with the British Westinghouse Electric and Manufacturing Company, Limited, as contractor, under which that company undertakes:—(*a*) To execute the works and

provide the plant necessary to enable the traffic of the railway to be worked by electrical traction within 18 months from July 15th 1901. The contract also contains guarantees as to the materials and workmanship and the sufficiency and economy of the plant. (*b*) To guarantee the interest on the existing 4½ per cent redeemable first debenture stock, amounting to £249,276, until the works shall be available for public traffic worked by electrical power; and to provide the sum of £249,276 not later than June 30th, 1904, for the purpose of redeeming this stock. The contract price for the works and financial obligations is £635,303, and is payable to the extent of £620,000 in 4 per cent. Mersey Railway new first perpetual debenture stock (part of the £703,750 authorised by the Acts of 1898 and 1900), and £15,303 in cash. It is believed that by the adoption of electrical traction the receipts of the company will be greatly increased through the abolition from the tunnel of the smoke and fumes caused by steam locomotives, and the running of a more frequent and quicker train service. It is also anticipated that there will be substantial economies in the cost of working.

Musselburgh.—Mr. Allbright, the manager of the company promoting the tramway scheme, has explained to the T.C. that difficulties had presented themselves to the company in financing the scheme. Mr. Allbright could hold out no expectation that the work would be proceeded with within any specified time.

Newcastle.—The T.C. has authorised the Tramways Committee to advertise for and appoint a general manager for the tramways at £750 per annum; also a traffic superintendent at £300; a power station superintendent at £250; and a rolling stock superintendent at £200.

Oldham.—The Lees D.C. has interviewed the Oldham Corporation Tramways Committee with the object of arranging terms on which the Corporation would continue their electric car service from Leesbrook (Oldham boundary at Lees) through the township of Lees. The Corporation was asked if it would be willing to extend the service 666 yards if the D.C. laid the rails, and on what terms as to payment of interest on the outlay. A syndicate had offered to run cars through the district, and the place was so small, that it would not pay the Council to run cars on their own account. They preferred to deal with the Corporation. The Oldham Tramways Committee approved of the proposals, subject to proper terms and arrangements. The D.C. will proceed almost at once to obtain prov. orders for a tramways and electricity supply.

The large car shed in Wallsham Street, Oldham, is being rapidly pushed forward. When the whole network of electric car service is complete in the town, it is expected 150 cars (Dick, Kerr) will be in use.

Perth.—The T.C. having resolved not to take over the tramways, the company now wish the Corporation to grant them a 32 years' lease, provided they convert the present horse haulage into an overhead electric system. In 1898 the company applied for the necessary powers to work the tramways by electricity, and these were obtained. The Council have not yet given their decision regarding the lease.

Portsmouth.—In consequence of the death of President McKinley, the inauguration of the electric tramways, which was fixed for yesterday (Thursday), has been postponed until Tuesday next.

Prestwich.—At the U.D.C. meeting last week Mr. Kendall, chairman of the Electric Lighting and Tramways Committee, asked that Manchester should fulfil their part of an agreement which had been in their possession since February, or free the hands of the Council in the matter of the tramways. Some discussion took place as to whether something might not be done with Salford, but Mr. Kendall's resolution was ultimately carried.

Rochester.—The Works Committee is to consider and report upon the desirability of the Council applying for powers to establish a system of municipal tramways.

Rowley Regis.—At Rowley on Monday night a conference took place between members of the Dudley Town Council and the Rowley Regis District Council, in order to formulate a scheme for obtaining powers to construct an electric light railway between Dudley, Rowley, and Birmingham. The decision arrived at has not transpired.

Sedgley and Bilston.—Rapid progress has been made during the past fortnight with the construction of the electric tramway between Sedgley and the Fighting Cocks—that is, the boundary of Wolverhampton. With the exception of a short rail here and there connected with the turn-outs, the whole length is now laid from Dudley and Sedgley to the Wolverhampton boundary. The whole of the concreting is, as near as possible, down, whilst the paviors are hard at work at both ends. The overhead wires are also fixed, and it is hoped the line will be ready for opening next month. The construction of the line between the Fighting Cocks and Bilston will shortly be commenced, most of the materials to be used having already arrived in the district.

Singapore.—A project for electric tramways has been brought up by two gentlemen (one a Mr. Dickenson), who want a 50 years' concession. The Municipal Commissioners have had a discussion on the matter, and seem to be very favourably inclined toward the proposal.

(Continued on page 480.)

LARGE GENERATORS.

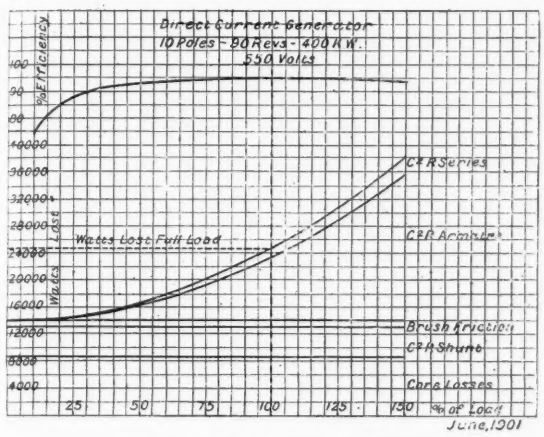
Since the English Electric Manufacturing Company, Limited, began the manufacture of electrical machinery at the new Preston works in June of last year, nearly 1,500 tramway motors, varying in size from 25 H.P. up to 100 H.P. each, have been completed and shipped to their various customers. In addition to this they have supplied the necessary controllers, rheostats and car equipment for about 750 cars. The production of tramway equipments, however, is only one department of their business. A much more important part of the factory is now fully employed in the production of direct current generators, both for lighting and power. The company has received, during the year, orders for a large number of these machines, varying in capacity from 100 to 1,200 KW. Some three months ago the first of these generators was shipped, and since that time machines of varying sizes have been forwarded from Preston, not only to cities and towns in England, but also to South Africa and India. The Preston generators are remarkable for their extreme simplicity in design and the very few parts which constitute a complete machine, as may be seen in the photographs which follow.

The magnet frame is circular in form, and is made of a special quality of cast-iron, having a very high magnetic permeability; it is provided with inwardly projecting pole-pieces, and is divided horizontally, so that the upper half of the frame can be removed for the inspection or removal of the armature. The lower half of the frame is provided with two large feet, to give a firm footing upon the foundation girders. The poles are made of the finest quality of laminated steel, cast into the magnet frame with a cast welded joint, thus ensuring a very low reluctance in the magnetic circuit; they are also provided with detachable pole shoes, which act as supports for the field magnet spools. A test piece is taken from every frame casting and submitted to the most careful determination of its magnetic qualities; the sheet-steel which is used in making the laminated pole-pieces is also submitted to the same test, and any material which does not come up to the required standard is rejected.

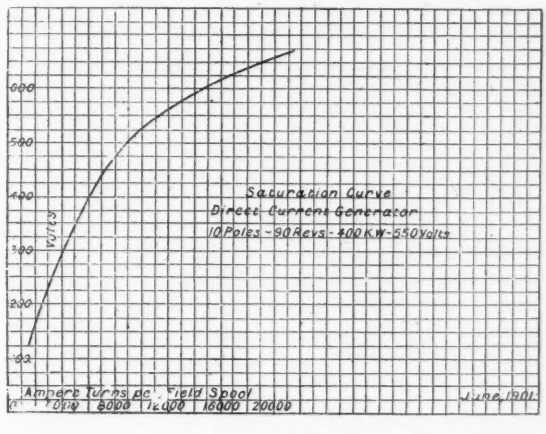
The field coils are wound upon spools made of steel with brass ends. One portion of the spool is occupied by the shunt winding, which consists of double-cotton-covered copper wire of 100 per cent. conductivity; the other portion of the spool contains the series winding, of copper ribbon, there being only one turn per layer, insulated most thoroughly with mica and cloth.

The shunt coils and the series coils are insulated from each other by a combination of mica and red rope paper, and both coils are insulated from the spool by at least ¼ in. of the same insulation. After the winding is completed, the surface of the coil is carefully covered with a heavy paper wrapping, secured with a layer of braided rope covering, filled with insulating varnish. The finished coils are placed in a large baking oven, where they remain for several days, the temperature being high enough to drive the last vestige of moisture out of them. The varnish in the insulation, and that in the covering, hardens during the baking process, so that there is no opportunity for moisture to re-enter. These coils, while hot, are subjected to an alternating pressure of 2,500 volts between the windings and the spool or frame of the machine. No joints are made in either the shunt or series winding, except at the surface of the coils, where they can be examined and kept tight. The pole-faces of the magnet cores and pole-shoes are bored out after the coils are in place, and the machine set in the position in which it is to run; this permits the frame to take the form which it will have when finished ready for service, and ensures the bore being exactly circular to receive the armature. The latter is, of course, the most interesting part of the generator. It is built on armature spider cast from the best quality of strong, tough iron, and so designed that all shrinkage strains are avoided; this is provided with a long bearing surface for the shaft of the engine to which it is to be fitted. It is bored accurately to a gauge supplied by the engine builder, and is made slightly smaller than the diameter of the shaft, so that it requires about 100 tons pressure to force it into position; it is then secured with two keys.

The armature core is built on the ends of the arms of the hub, and consists of punchings made from the best magnetic steel. Before assembling, the armature laminations are thoroughly annealed and japanned to prevent hysteresis and the formation of eddy currents. At intervals of 3 or 4 in. spacing discs are inserted between the laminations, to form ventilating ducts for cooling the interior of the core and the



Curves of Efficiency and Losses.

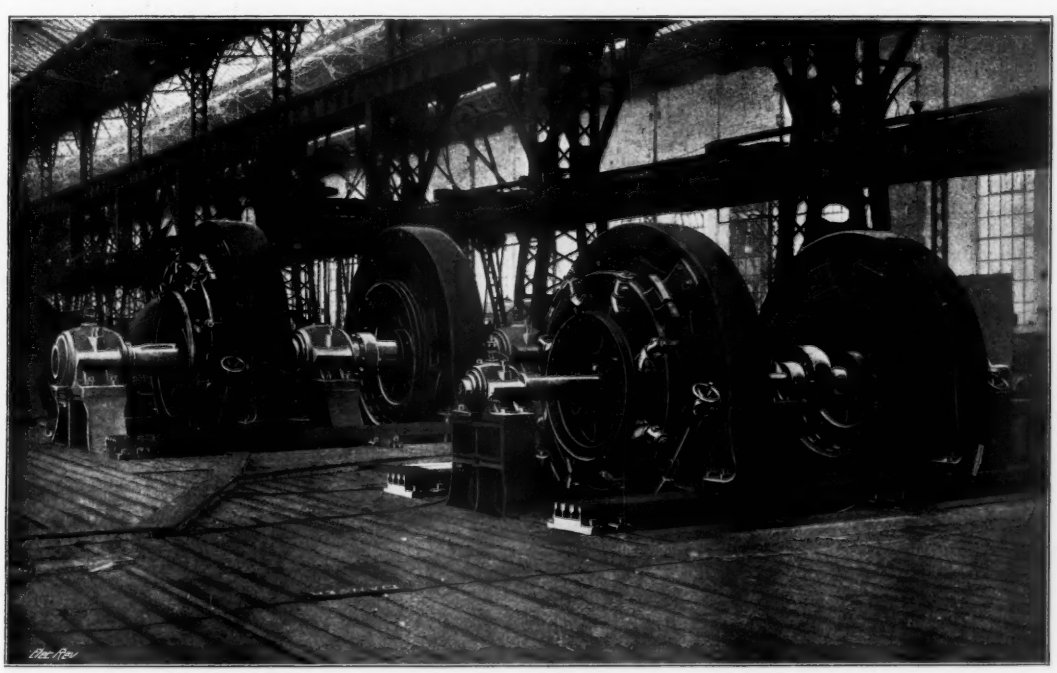

Saturation Curve
Direct Current Generator
10 Poles - 90 Revs - 400 K.W. - 550 Volts
Volts
Ampere Turns per Field Spool
June, 1901

Magnetisation Curve.

windings. After a sufficient number of these armature laminations or discs are built together to form the armature ring or core, they are clamped in place by cast-iron flanges, which are also made to support the armature windings which extend beyond the ends of the armature core. The periphery of the armature core is provided with open slots to receive the armature coils; these are made by bending copper ribbon over a suitable former, making them all alike and interchangeable. It is, therefore, easy to wind the armature and to replace injured coils. The armature conductors are thoroughly insulated from the core and from each other with a special material, consisting largely of mica, rendered impervious to moisture by a superior varnish. Like the field coils, the armature coils are subjected to a baking process which renders them perfectly dry. The insulation of the entire armature circuit is subjected to a high pressure A.C. test while hot. An extension of the armature spider carries the commutator hub, to which it is securely keyed, thus preventing any relative motion between the commutator bars and the armature windings. On the periphery of the commutator hub the hard drawn copper commutator bars are firmly clamped by means of steel end rings. The insulation between the bars and the hub is made from the purest India mica, while that between the bars is made from a special kind of silver amber mica; this insulation is so carefully made that in testing between the commutator bars and the hub, the alternating pressure may be made so high that the current will creep over the edge of the mica rings, a distance of from 1 to 2 in., without puncturing. To the back end of the commutator bars, flexible copper bars are rivetted, extending radially up to and connecting with the armature windings. The joints are all exposed and can be inspected at any time, so that if repair is required it is only the work of a few moments.

The electric pressure between adjacent commutator bars is kept under 10 volts, so that there is no possibility of an arc standing between the bars over the $\frac{1}{32}$ of an inch space between them. A balancing device is attached to the commutator to equalise any slight difference in the magnetic reluctance of the various magnetic circuits of the multipolar machine, thus checking the slightest tendency to spark.

The brushes used to collect the current from the commutator are made of the purest carbon; they are held in position by brush-holders carried on laminated copper strips, giving an easy, adjustable pressure which will follow any



Large Generators Coupled together for the Hopkinson Test.

irregularities in the commutator. The brush-holders are so designed that no moving joints carry the current, and are mounted on a massive rocker ring supported by four brackets attached to the generator frame. All of the brushes can be rocked simultaneously by means of a hand wheel and screw geared to the brush rocker ring. Two massive copper connecting bars, concealed inside the brush rocker ring, collect the main current from the brush-holders and deliver it to a connection board at the bottom of the machine.

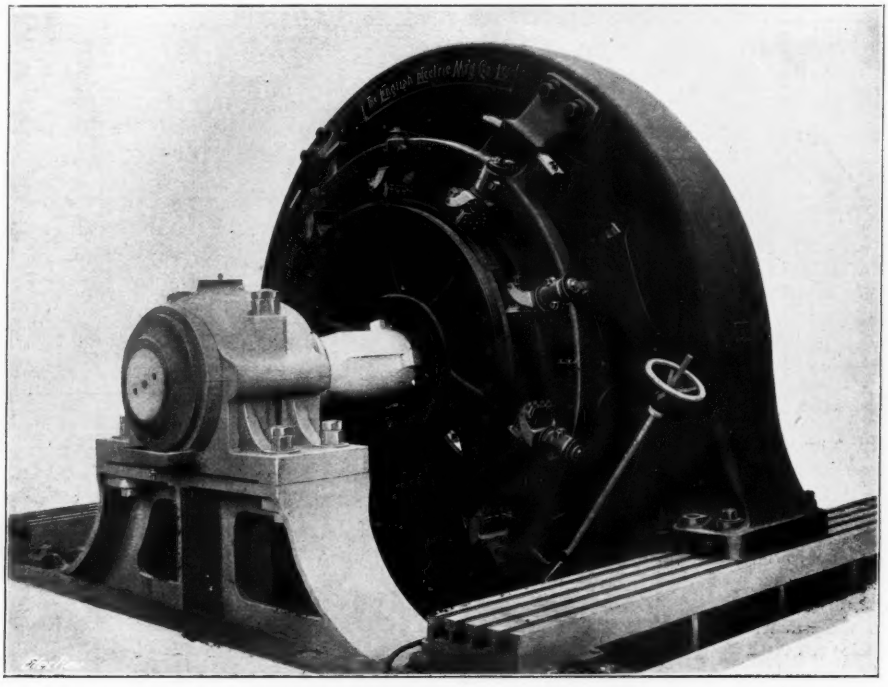
The company has provided two large testing pits near the shipping department, where these large machines are erected and submitted to the severest possible test. They are run for 10 and sometimes 24 hours continuously, at full load, and are subjected to from 30 to 50 per cent. overload in addition to the all day run at full load. The remarkable performance of these machines is illustrated by the low temperature rise and high efficiency which they are said to show. A 400-KW. machine which was recently tested, after running for 10 hours at full load, was made to carry a 50 per cent. overload for two hours, and only showed a rise in temperature of 57° F. above the surrounding air, measured by the thermometer. The commutators at the end of this severe test did not even feel warm to the hand. The performance at the commutator is also remarkable in that there is absolutely no sparking under any condition of load, and without the slightest movement of the brushes. In fact, the longer the commutator runs, the more beautiful the polish which it assumes, due to the action of the carbon brushes upon the surface of the hard-drawn copper.

The tests made upon this machine were by the Hopkinson method, as shown in one of our photographs, so that the losses in the various parts of the machine were determined and the efficiency arrived at most accurately.

The curves showing the losses and efficiency are given on p. 475. An open circuit magnetisation curve was also plotted, which shows the excellent quality of the material used in the construction of these machines.

These qualities in a generator will be appreciated not only by managers of lighting stations because of the high efficiency and splendid regulation, but particularly by the engineers in charge of railway power stations, where the fluctuations of load will one moment require the generator to work to nearly double its capacity, and the next moment the load will be entirely off. With machines of this kind great irregularity in the demand for power will not in any way make it more difficult to operate a station than if the load were absolutely constant, because the machines will perform just as well under these great variations as they will under constant load.

Another great advantage in having generators which will



LARGE GENERATOR ON TESTING BED.

GLASGOW TRAMWAYS: ROSETTE CONSTRUCTION IN GREAT WESTERN ROAD.

GLASGOW TRAMWAYS: CENTRE POLE CONSTRUCTION IN GREAT WESTERN ROAD.

carry a very large overload for several hours at a time without injurious heating, is that they will take care of heavy tramway loads on holidays and in the mornings and evenings, when everything is taxed to its fullest extent. These machines, as they are being manufactured at Preston, are certainly highly creditable to the company, and are likely to play an important part in future efforts to meet foreign competition.

GLASGOW ELECTRIC TRAMWAYS.

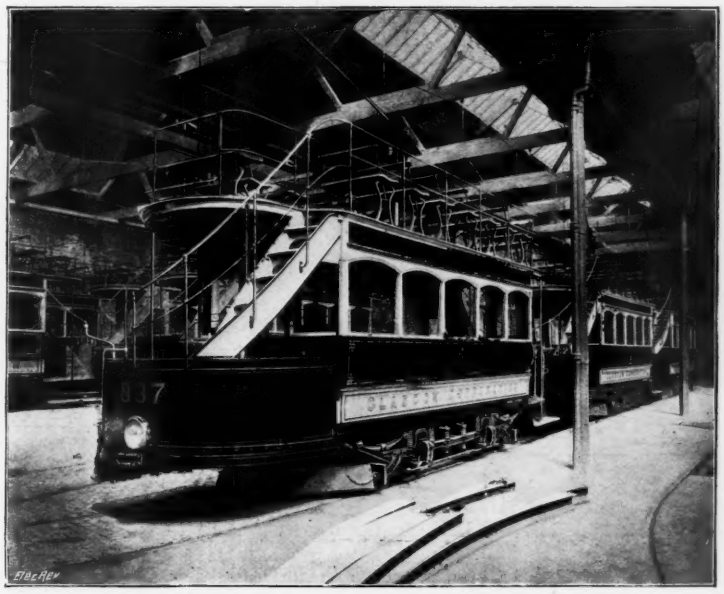
(*Concluded from page* 438.)

The overhead construction is carried out as far as possible on the span-wire system, with rosettes; Messrs. Macartney, McElroy & Co., Limited, were the contractors for this work. The rosettes are of cast-iron, with rubber buffers to diminish vibration. The trolley wire is of No. 00 B. & S. gauge, divided into half-mile sections. The span wires are of 7/12 S.W.G. galvanised steel. The guard wires, which are earthed, are of No. 7 S.W.G. steel wire, with 7/14 galvanised steel wires. The trolley is of the "straight under-running" type, so that the trolley wire is directly over the centre of the track.

Centre pole construction is used in certain parts, notably over Glasgow Bridge and in the Great Western Road. Where this is the case the poles are surmounted with arc lamps. Bowstring suspension is used, to avoid shock to the trolley.

There are three patterns of feeder pillars, equipped respectively with four, three, and two 400-ampere switches; in every case there are also two 200-ampere switches, and the necessary bus bars, cable sockets, &c. These are mounted on a marble slab, polished on both sides, and bolted to wooden battens. The switches and bus bars are insulated from the marble with ebonite. The feeder pillars are of cast-iron, with doors back and front.

A very complete system of telephonic communication has been provided; this has no connection with the Corporation exchange system. The "Traction" telephone system introduced last year by the General Electric Company (1900), Limited, has been adopted, with modifications which enable communication to be obtained not only between the feeder and street pillars and the sub-stations, but also between the former and the head office; moreover, by means of exchanges at the head office and the power station, any part of the system can be put in communication with any other part.



Cars in Whitevale Depot

A hundred-line switchboard at the head office provides for communication with Pinkston power station, five sub-stations, depôts, and all the official residences of the staff—in all about 35 stations. This board is of the G.E. Co.'s standard double-line pattern, with 100 indicator drops and jacks, &c., and a corresponding carbon lightning arrester and distribution board; the instruments are of the G.E. Co.'s K 69 pattern, with magneto call and Hunnings cone Deckert transmitter. In connection with this board there are also about 40 telephone street posts of the company's make, fitted complete with calling apparatus, transmitter and receiver, and provided with lock-up doors. A key is carried by every official and tramcar conductor.

A 12-line switchboard at Pinkston power station is used for speaking with the sub-stations and the chief official residences.

Street View, showing Traction Telephone in use.

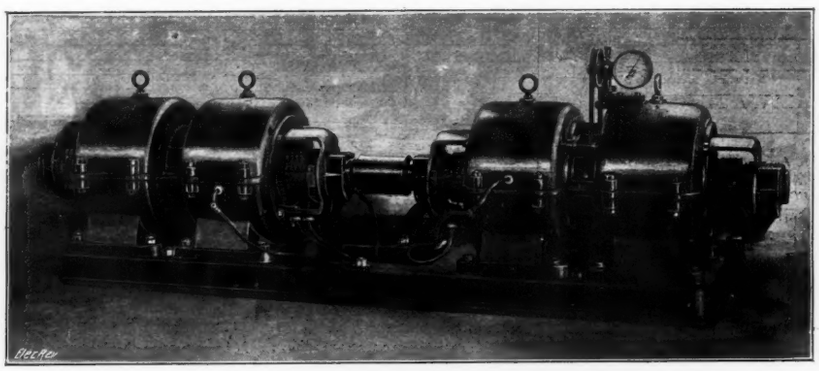
Every feeder pillar, of which there are 142, is fitted with a G.E.C. plug box, of the type which we recently described; these are connected respectively with the nearest sub-station. Upon the insertion of the four-pronged plug of the portable

performance at the commutator is also remarkable in that there is absolutely no sparking under any condition of load, under constant load.

Another great advantage in having generators which will

pocket telephone set a bell is set ringing at the sub-station until the receiver is lifted off the hook, when communication is at once established.

To provide for this unique system of intercommunication, a very large number of telephone wires had to be laid down; the largest cables consist of 50 pairs each, and sometimes



Farnworth: Balancer-Booster Set.

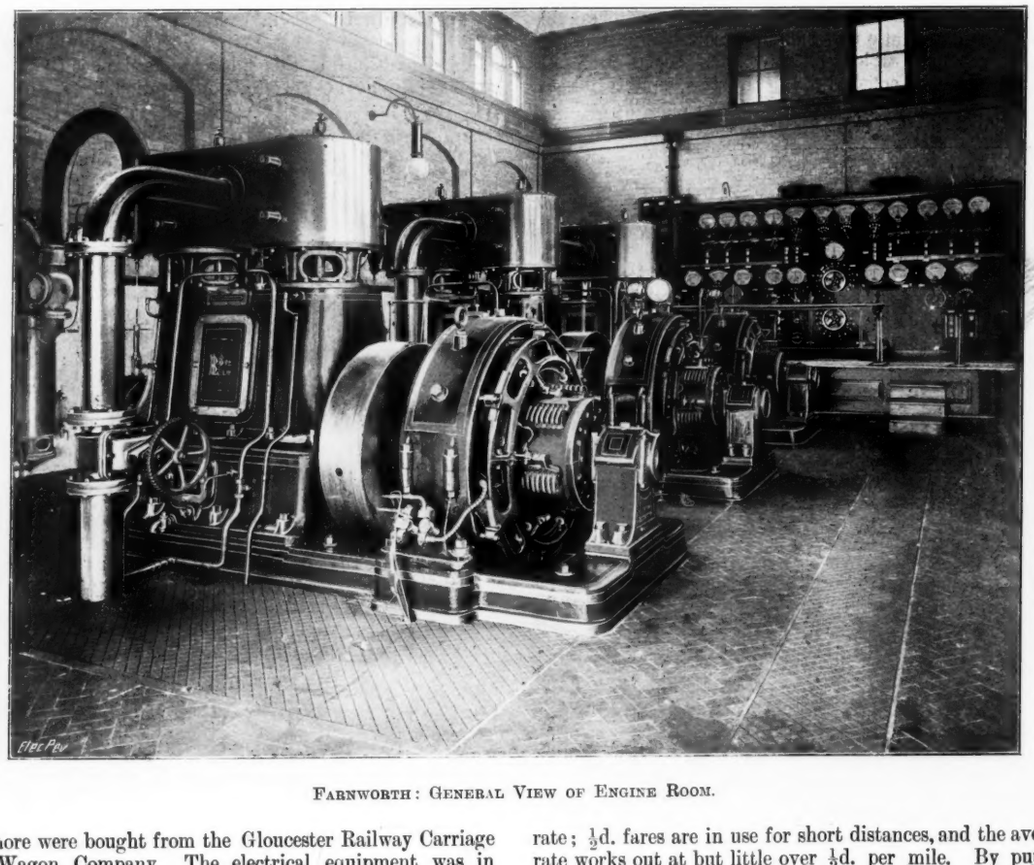
several of these run side by side. They were made by the National Conduit and Cable Company, and drawn into the ducts already described.

Most of the car bodies have been built in the Corporation workshops at Coplawhill, on the south side of the Clyde; here extensive car sheds, stables and workshops were erected when the tramways were taken over, and on the advent of electric traction the shops were largely extended. Over 300 car bodies have been built by the staff of the department; 80 more were bought from the Gloucester Railway Carriage and Wagon Company. The electrical equipment was in every case carried out at Coplawhill. All the cars are of the double-deck type, except 21 single-deckers, which were originally built for the Springburn route. The double-deck cars have a seating capacity of 25 inside and 30 outside. The trucks are of the four-wheel extended spring base type, and were supplied by the Brill Company. The wheel base is 6 ft., and the length over all 28 ft. The wheels are of chilled iron, made by Messrs. Miller & Co., of Edinburgh, and are 30 in. diameter, weighing 300 lbs. apiece.

Each truck is equipped with two Westinghouse motors, pattern 40 B, and No. 90 controllers, with the usual accessories. Each of these motors, which were specially designed for city traffic, is capable of exerting a horizontal effort of 1,600 lbs. at 7½ miles per hour; they have four-pole fields, with laminated soft-steel poles, and two-circuit drum armatures.

The trolley is of the Blackwell type, with rigid head, and external springs, which are arranged so as to give practically constant pressure on the trolley wire.

The service is very popular, the charges being very moderate; ½d. fares are in use for short distances, and the average rate works out at but little over ½d. per mile. By putting forward every effort, the electrical service on the Exhibition routes was inaugurated in time for the opening of the Exhibition, and this fact no doubt has contributed largely to the success of both undertakings.



Farnworth: General View of Engine Room.

cast-iron, with doors back and front.

A very complete system of telephonic communication has

these are connected respectively with the nearest sub-station. Upon the insertion of the four-pronged plug of the portable

The general manager of the tramways is Mr. John Young, to whom we are indebted for facilities to photograph the works. Mr. W. Clark is the chief engineer, and Mr. M. B. Field the electrical engineer. The whole of the power equipment was designed by Mr. H. F. Parshall, as consulting engineer, and carried out under his supervision; Mr. Parshall was represented on the work by Mr. Dyson.

Our thanks are due to these gentlemen, and to the various contractors, for the particulars embodied in the foregoing description.

FARNWORTH ELECTRIC LIGHT AND TRAMWAYS UNDERTAKING.

The Urban District Council of Farnworth recently inaugurated the commercial supply of electrical energy. The district controlled by this authority is a very large one, having a population of 30,000, and the Council recognised that a good electric lighting and tramways system is essential to the comfort and welfare of the inhabitants.

Messrs. Lacey, Clirehugh & Sillar were appointed as consulting engineers in 1899, and on their advice a combined lighting and traction scheme was decided on as being the most economical.

After a Local Government inquiry in April of last year, a loan of £22,000 was granted to be spent on the combined scheme. Since then the work has been successfully carried out by the respective contractors under the supervision of the consulting engineers; Mr. J. D. Pember, the resident engineer, has also given valuable assistance in the work.

The works are conveniently situated in Albert Road. The provisional plans of the buildings were supplied by Messrs. Stones & Stones, of Blackburn, the work of erection being carried out by Mr. S. J. Hodgkiss, of Farnworth. The buildings comprise boiler and engine room, test room, and offices, adequate provision being made for extensions. The accumulator room is in the basement, with the regulating cells under the back of the switchboard, thereby simplifying connections to the board and also dispensing with mechanical transmission gear from the switch in the accumulator room to the switch on the board. A reservoir has been constructed near the works for condensing purposes.

The steam generating plant comprises three Lancashire type boilers, supplied by Messrs. Edwin Danks & Co., of Oldbury. Each boiler is 30 ft. in length and 7 ft. 6 in. in diameter, with a heating surface of 1,001 sq. ft., and works at a pressure of 150 lbs. per sq. in. They are provided with the necessary safety, high-steam and low-water safety valves, and two accessible check-feed valves. The economiser, supplied by the same firm, is of the "Green" type, and consists of 192 pipes, 9 ft. long, $4\frac{2}{16}$ in. diameter, arranged in rows eight tubes wide, the whole being forced by hydraulic pressure into longitudinal top and bottom boxes in sections, forming metal to metal joints. The pipes are arranged in two groups, and fitted with deflectors at the back. The blow off from the economiser is carried to a reservoir.

The boiler feed pumps, supplied by Messrs. Datsons, of Newcastle-on-Tyne, comprise two single-cylinder direct-acting vertical sets. Each pump is capable of delivering 1,500 gallons per hour against the boiler pressure.

The generating sets comprise three 120-kw. steam dynamos. The engines, supplied by Messrs. Browett, Lindley & Co., are of the two-crank vertical compound type, enclosed and self-lubricating, capable of developing 200 i.h.p. at a speed of 480 revolutions per minute, with a steam pressure of 140 lbs. per sq. in. in the steam chest, and working condensing with a vacuum of 24 in.

The engines are direct coupled to dynamos supplied by the Lancashire Dynamo and Motor Company, of Trafford Park. Each dynamo has an output of 120 kw., the current output as a shunt machine being 250 amperes at a voltage variable between 440 and 480 by means of a shunt resistance, and as a compound machine at a constant pressure of 525 volts at constant speed. The dynamos are 6-polar, with bar-wound barrel-type armatures. The above outputs are the normal maximum outputs, but each set is capable of developing 240 i.h.p. on emergency.

The balancer-booster set, supplied by the same firm, consists of four separate armatures mounted on two coupled shafts, supported on four bearings from one base-plate. The balancer works with one armature on each side of the three-wire network, each armature running as either motor or generator, at a difference of potential of 220 to 250 volts, and a current of 50 amperes. Each booster armature is capable of raising the charging voltage by 100 volts at a current output of 120 amperes.

The lighting and traction switchboards were supplied by Mr. Bertram Thomas, of Manchester. The lighting board is built up of panels of enamelled slate, on which the measuring instruments are mounted; the latter are of the Evershed & Vignoles type. The traction board has three dynamo panels, one feeder panel, one centre panel, and the usual Board of Trade panel. The measuring instruments on this board are of the Weston type, and the automatic circuit breakers of the I.T.E. type.

The accumulators, supplied by the Tudor Accumulator Company, consist of 252 cells, including four spares, and are capable of giving a discharge of 40 amperes for a period of 10 hours, or 160 amperes for one hour, the E.M.F. of each cell being not less than 1·8 volts at the end of discharge.

The mains, supplied by the British Insulated Wire Company, of Prescot, were put down under the supervision of Mr. A. J. Macphail; the feeders terminate in two pillars, whence several distributors are taken. The chief class of cable is five-cored lead-covered and armoured, with a layer of bricks laid on the top as a protection. The distributors are three-cored. Already an order has been given for an extension cable down Church Street, as there is a considerable demand in that quarter.

There is about a mile of double track tramway being operated by the Bolton Corporation under a lease which will expire in the spring of next year, but in addition to this the Farnworth Council are laying about three miles of single track in the town. The overhead equipment for the old track was put up by Messrs. George Hill & Co., of Manchester. The British Insulated Wire Company have obtained the contract for the overhead equipment of the additional track.

Eight new cars are now on order; the car bodies are being supplied by Messrs. George Milnes & Co., and the trucks and motors are of the Westinghouse manufacture.

The car shed is situated close to the works, and is being erected to the design of the surveyor of the Council, Mr. W. J. Lomax. It will accommodate about 15 cars, and has four lines of track with an outside traverser. It will be fitted up with the usual complement of offices, stores and workshop.

The Committee have adopted the principle of letting out motors on hire, and they are considering, but have not finally settled on, a system of easy payment for the wiring of premises.

Before the end of this month there will be between 40 and 50 consumers connected to the mains. Until the opening ceremony the consumers connected were provided with free lighting.

The street lighting will consist of 45 Brockie-Pell arc lamps, each taking 10 amperes, which will be supplied and erected by the British Insulated Wire Company. They will be fixed on the top of nearly every alternate tramway pole. For lighting after midnight, two incandescent lamps on each pole used for arc lighting will be used, being fixed on brackets about halfway up.

The electricity works was formally opened on August 28th, 1901, by Mr. W. B. Richardson, chairman of the Electricity Committee, who has taken a very keen interest and displayed great abilities in discharging the duties of chairman.

Our thanks are due to Messrs. Lacey, Clirehugh & Sillar, consulting engineers to the Council, for the foregoing particulars of the installation.

Germany.—A service of electrical omnibuses has just been inaugurated between Glambecksee and Stettin, Germany. Two vehicles built by Messrs. Stoewer Bros., of Stettin, are at present in use, but three more are in course of construction.

The South German Railway Company, of Mainz, has secured the concession for the construction and working of an electric railway between Mainz and Wiesbaden.

ELECTRIC TRACTION NOTES.

(*Continued from page* 474.)

Southampton.—The B.C. is applying for powers for additional tramways. Mr. F. H. Chaplin has resigned the position of borough electrical engineer, and a successor at £500 per annum is to be advertised for.

Southport.—The B. of T. inspector has made an examination of the newly completed Roe Lane section of electric track, with which he expressed his satisfaction, but took exception to some details in the cars, which required life-guards under each end of the cars and sand boxes above the wheels to ensure a grip on the rails in wet or frosty weather.

The T.C. will apply to B. of T. for powers to construct a line of tramway in Ash Street.

The fifth annual report of the electrical engineer, which came before the Council, showed that, owing to the high price of coal, the surplus for the year was less than had been expected, being only £700, roughly. The gross profit for the year had been £7,292, against £6,384 the previous year. This meant a return of 5·5 per cent. on the capital invested at the end of the year. The sum of £10,677 had been paid in reduction of debt since the undertaking began.

Springhead.—The D.C. has discussed the tramway question. It was argued that, seeing Lees was going in with Oldham, they at Springhead ought to try and arrange with Messrs. Hewitt & Rhodes, who had proposed a scheme for Lees, Springhead and Saddleworth, but Oldham would not allow any company to run over their lines, and as Lees had decided to have nothing to do with the company, the service would be confined to their own district. Then it was suggested that they should approach Oldham, but the length of the tramway they would have to construct would cost too much. It was eventually decided to approach Messrs. Hewitt and Rhodes as to the laying of tramways in this district on terms to be agreed upon.

Stockport.—After the accident which occurred on the evening of 10th inst. on the Lancashire Hill section of the Stockport tramlines, the Tramways Committee at once closed this section until a brake could be fitted to the cars of such a nature as to render their running away an impossibility. The Committee consulted Messrs. Hewitt & Rhodes, tramway engineers, of Manchester, who have designed a new form of slipper brake, which is worked pneumatically, and which, we are informed, has been successfully adopted in Oldham, where exceptionally steep gradients are met with. Some members of the Stockport Tramways Committee have witnessed trials of the new brake, and are highly satisfied with the quick and effective manner in which cars are controlled and stopped on the heaviest gradients, and with the ease with which the brake is manipulated. Instructions were accordingly given for similar brakes to be supplied for the Stockport cars, and it is expected that they will be equipped and running again within the course of a few days.

Sunderland.—The proposal to lay a section of tramways down High Street East was before the Council again last week. The cost of the line is to be £17,486, a considerable proportion being for the cost of alterations to the road; all the levels and gradients will have to be altered. The chairman of the Committee, Mr. F. J. Trewhitt, said he would not oppose the scheme, but asked the Council to be careful as to what they did, pointing out that the recent extension from the Cedars to High Street corner only earned from 7½d. to 8d. per car mile, and consequently would mean a loss of £1,000 a year. The cost of the proposed route to the East End would work out to 9¾d. per car mile, and with a population which was constantly decreasing, they should take thought before expending much money. In that part of the street which would have to be levelled there were 26 property owners, of whom 21 had consented to the alteration, so that five would have to be compensated. Ultimately, after expression had been given to the opinion that so long as the whole system paid, the Council should not pay too keen attention to a single route, the scheme was approved on the condition that the owners who would be affected by the alteration gave their consent.

At the last meeting of the Council it was decided to adopt the Tidswell Automatic Life Guard for the cars in use in the borough. The cars are already provided with guards of a simple description, but Colonel Von Donop recently expressed himself dissatisfied with them, and suggested a change, hence the recommendation of the Committee. The change will cost £250 to effect.

Sydney (N.S.W.).—Fire has damaged the switchboard and the dynamos in the electric power house to such an extent, that the tram service has had to be suspended for several days.

Twickenham.—There was an animated discussion at the last meeting of the U.D.C. with reference to the site of the L.U.T. tramway terminus, the company proposing to have it at a point where the roadway is very narrow. It was decided to urge the company to make the terminus a little distance away at a more convenient spot, or else to provide a tramway station and waiting room for passengers.

The Underground.—This week the news relating to this matter is that the question "is likely to be settled in the near future." We learn this startling piece of news from that sensational newspaper, the *Daily Mail*, so it must be true. It is further added that the Board of Trade has appointed the Hon. A. Lyttleton as arbiter, before whom Mr. Parshall will act for the District Company, and Mr. Parker for the Metropolitan.

Wimbledon.—The B.E.T. Co. have approached the U.D.C. with a view to promote a tramway to connect their nearly completed system at Croydon with Wimbledon, *viâ* Mitcham and Merton. The chief difficulty lies in the fact that Mitcham has already secured a light railway order, for the purchase of which the London United Tramways are also negotiating.

Worcester.—The Worcester (Extensions) Light Railways Order has been submitted to the Board of Trade for confirmation.

TELEGRAPH AND TELEPHONE NOTES.

Leeds Telephones.—The T.C. recently appointed a special committee to inquire into the question of municipal telephony, and, if necessary, to visit other cities and call in expert evidence.

Poland Telephones.—Work is at present in hand on the establishment of an interurban telephone line between Warsaw and Lodz.

Sheffield Telephones.—The T.C. has appointed a committee to report *re* municipal telephones.

Spain.—An extraordinary credit of 250,000 pesetas (£10,000) has just been voted by the Spanish Government for the repair of the telegraph cable between Teneriffe and Cadiz, while for the purchase of new telegraph material and apparatus a sum of 284,000 pesetas (£11,360) has been voted.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Para-Maranham	March 1, 1900	
Cadiz-Teneriffe	Aug. 6, 1901	
Bissao-Bolama	Aug. 16, 1901	
Trinidad-Demerara	Aug. 26, 1901	Sept. 16.
Curacao-Coro	Sept. 5, 1901	
Gibraltar-Tangier	Sept. 13, 1901	
Landlines :—		
"*Via* Hanekin" on Persian territory	Feb. 24, 1900	
Pekin-Kalgan	June 14, 1900	
Maimatchin-Kalgan	June 30, 1900	
Communication with Baranquilla and Cartagena towns of Venezuela	Dec. 8, 1900	
"	Oct. 31, 1900	

Wireless Telegraphy.—It is stated that Messieurs Renard, the French æronauts, have discovered a method of utilising wireless telegraphy for communicating with captive military balloons. Experiments will be made at the review at Betheny in presence of the Czar.

The experience gained of the value of the Marconi system of wireless telegraphy on the *Lucania* has impelled the Cunard Company to decide upon fitting up the *Campania*, the *Umbria*, and the *Etruria*.

The account of the recent manœuvres, prepared by the umpires, testifies to the success of wireless telegraphy as a medium of communication between one vessel and another, except in the case of the *Arrogant*, which was informed of the commencement of hostilities by semaphore from St. Mary's coastguard station, the wireless telegraph in this case being inefficient.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackpool.—September 21st. 20 tramway carriages for the Tramway Committee. Specification from Mr. J. Lancaster, tramways manager.

Blackpool.—Tenders for 30 arc lamps, switches, &c., for rectified current, for the Corporation. See "Official Notices" September 6th.

Boulder City.—November 23rd. The Council invite tenders from manufacturers for the construction of a tramways system, plans and specifications of which are to be seen at the office of the Agent-General, London. They also invite tenders for a concession of the franchise over Boulder territory. The position is unique inasmuch as the residences of the chief producers of the universally known Golden Mile are clustered round Boulder City, but at a distance that will give a tramway system a permanent and regular traffic. The system will also hold the key to all transit facilities on the field. The city already owns an electric light service which is proving wonderfully profitable. The population is increasing daily, and by its close proximity to the mines must become the principal business, as it is already the residential centre of the Kalgoorlie or East Coolgardie goldfields. See "Official Notices" to-day.

Bray.—October 3rd. Twelve months electrical supplies for the electric light works. See "Official Notices" September 13th.

Colne.—September 28th. Wiring the Town Hall and Market Hall. Corporation. See "Official Notices" to-day.

Doncaster.—September 27th. Tenders for a 220-KW. high speed steam dynamo, piping, valves, &c. See "Official Notices" September 13th.

France.—October 1st. The French Post and Telegraph Authorities in Paris are inviting tenders for the supply of a multiple telephone table for the telephone exchange at Lille. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

France.—September 24th. The French Minister of Posts and Telegraphs in Paris is inviting tenders until the 24th inst., for the supply of 145 kilometres of submarine cable core, 35 tons of iron wire, 2½ mm. diameter, 45 tons ditto, 5 mm. diameter, 50 tons ditto, 7 mm. diameter, and 25 tons ditto, 8 mm. diameter. Tenders to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Greenwich.—October 10th. Installation for lighting the new Children's Homes for the Guardians. See "Official Notices" to-day.

Huddersfield.—September 30th. One set of 600-KW. alternating current generating plant for the electricity works. See "Official Notices" September 13th.

Huddersfield.—October 12th. Six car bodies, trucks and equipments. Corporation. See "Official Notices" to-day.

Hull.—September 27th. Two steam dynamos, arc and incandescent wiring for the destructor, sanitary departments, &c. Corporation. See "Official Notices" to-day.

Kingston-upon-Hull.—September 26th. The Corporation wants tenders for two high speed three-crank 800-I.H.P. compound engines and four Lancashire boilers. See "Official Notices" August 30th.

Kirkcaldy.—October 14th. Main switchboard. Corporation. See "Official Notices" to-day.

Leeds.—October 8th. Main switchboard to deal with output of three 1,500-KW. two-phase alternators. See "Official Notices" September 13th.

Maidenhead.—September 23rd. Three 60-KW. steam dynamos, two Lancashire boilers, economiser, &c., for the Corporation electric lighting. See "Official Notices" September 6th.

Manchester.—October 2nd. Ampere-hour and watt-hour meters for the Electricity Committee. See "Official Notices" to-day.

Newport T.C. has resolved to invite tenders for 30 electric cars, which is considered to be a sufficient number to open the new electric tramways with.

Newport (Mon.).—October 21st. Coal handling winches, piping, switchboard, cables, cable ways, overhead construction, electric motor car, repair shop equipment, and steel chimney shaft for the tramways and power supply undertaking. See "Official Notices" to-day.

Poplar.—October 1st. Electric lighting of four public libraries. See "Official Notices" September 13th.

Rathmines.—September 23rd. Meters and arc lamps; 12 months' supply. Council. See "Official Notices" to-day.

Rochdale.—October 2nd. The Electricity Committee wants tenders for feeder and distributor cables. See "Official Notices" September 13th.

Salford.—September 20th. Lighting the new generating station for the Corporation. See "Official Notices" September 6th.

Salford.—September 24th. The Tramways Committee advertise for tenders for fixing apparatus for supplying water to the electric car depôt, and also for wiring such depôt for electric lighting.

Sheffield.—September 30th. Boilers, motors, fans, iron chimneys, &c., for the electricity department. See "Official Notices" September 6th.

Stockton-on-Tees.—September 21st. Electric lighting of the Baths. Corporation. Borough engineer, Town Hall.

Willesden.—Economisers, boilers, piping and pumps, steam dynamos, battery, wiring, &c., for electricity works for the Willesden Infirmary. See "Official Notices" September 6th.

CLOSED.

Holland.—A German firm—the Phœnix Company, of Laar, near Rubrort—submitted the lowest tender for the supply of 5,000 tons of steel rails for the new electric tramway in Amsterdam.

Stepney.—The contract for the pipework extensions at the electricity works of the Stepney Borough Council has been obtained by Messrs. Aiton & Co., of Willesden Junction.

Sunderland.—The following is a list of the tenderers for the wiring of Hylton Road electric lighting station for the Corporation:—

Wear Electrical Company, Limited, Sunderland. (Accepted.)
Reid, Ferens & Co., Sunderland.
Brantinham Bros., Sunderland.
The Sunderland Forge and Engineering Company, Limited.
Emley & Sons, Limited, Newcastle-on-Tyne.
Falconer, Cross & Co., Newcastle-on-Tyne.
Robson, Robson & Co., Newcastle-on-Tyne.
Mr. T. S. Brown, High Bridge, Newcastle-on-Tyne.
Nicholson & Wadley, Newcastle-on-Tyne.
Mr. S. H. Gowdy, Newcastle-on-Tyne.
Mr. E. Geipel, Church Street, West Hartlepool.
W. H. Beilby & Co., West Hartlepool.
National Electric Wiring Company, Manchester.

Swansea.—The tender of Messrs. Handley & Shanks has been accepted for arc and incandescent lighting plant, including 150-H.P. engine, dynamo, switchboard, and wiring for 60 Jandus and 500 incandescent lamps, for the Upper Forest Tinplate and Steel Works, Morriston, near Swansea.

NOTES.

The Coal Smoke Nuisance.—We have received from the secretary of the "Coal Smoke Abatement Society" a letter in which he adverts to an article on the legal aspect of the question, which appeared in our issue of August 20th. He points out that the Society does not provide means for prosecuting opulent companies, but only makes reports to the various authorities of offences against the law from observations made by its inspector. The work done by the Society is best shown by the following extract from its report for 1900:—

> During the year 1900, our inspector reported to the committee 1,742 observations of offending shafts, and by their order presented 1,010 formal complaints to the Local Vestries, Borough Councils, and the Port Authority of London. In consequence of these complaints a large number of warnings and statutory notices have been served by the local authorities, and in 125 cases, the nuisances not having been abated, proceedings were instituted against offenders, which resulted in convictions, the fines amounting to £494 13s. Thus, since the establishment of the Society in March, 1899, the total number of observations has been 2,750; that of complaints, 1,690; and the amount of fines imposed, £714 19s. The area covered by these operations extends over 31 parishes, mostly in the Central and Western districts, and of these parishes 11 have been systematically inspected and reported on.

Stripped Railway Motor Armatures.—In a recent issue of the *American Electrician*, Mr. Frank Berry, jun., says:—"Among the various parts of motors found scattered about in the railway repair shop, not infrequently may be found a stripped armature. The most common of the various causes which lead to such a condition are worn bearings, a sprung armature shaft, or loosened bolts which permit the pole-pieces they hold to rub against the armature. As soon as the bearings supporting the armature shaft become worn to any extent they should receive immediate attention; otherwise they may wear sufficiently to permit the armature to chafe against the bottom pole-pieces. A sprung armature may be the result of loose gearing, or as is oftentimes the case, a piece of metal may break from the casting and wedge itself between the gear and pinion. To guard against sprung armature shafts due to loose gearing, the gears should be tightened up as soon as any noise from them is heard. The bolts which hold the pole-pieces in position, especially those at the top, very often work loose and are a source of serious trouble. The writer recalls an instance where the pole-piece dropped sufficiently, owing to loose bolts, to be caught and broken by the revolving armature; the broken part puncturing a great many of the armature coils. One of the very annoying circumstances connected with stripped armatures is the tendency of the armature bands to wind themselves about the brush holders. To guard against accidents of this kind every motor should be subjected to constant and systematic inspection."

Welsh Mountain Streams.—Mr. T. O. Edwards, the Government Inspector of Factories, Cardiff, has thrown out the suggestion that Welsh mountain streams should be utilised for generating electricity. He continues:—"The various District Councils have the power of doing this, and if it were done it would be an easy matter to supply cottages by an almost invisible wire to drive their looms."

Remember Lindsay.—The Lindsay memorial celebration took place at Dundee last Saturday, when an obelisk, which has been erected by public subscription over the grave of James Bowman Lindsay, of wireless telegraphy fame, was unveiled. Mr. A. H. Millar, the secretary of the committee, introduced the proceedings, and Sir W. H. Preece followed with a lengthy oration regarding the good qualities of all Scotsmen in general and J. B. Lindsay in particular. He ranked the prognostications of Lindsay sixty odd years ago in the matter of electricity as being superior to the prophecies of all scripture, for did he not say that "there is nothing in all scripture that is so marvellous, so clear, and so well defined, and so precise as the prophecies uttered by" the one to whose memory he had unveiled the obelisk in the Western Cemetery of Dundee. Sir William's speech was rife with pleasantries which gave satisfaction to those who heard him at the Technical Institute. Sir James Sivewright also spoke of the early achievements of Lindsay, and those who take a further interest in the proceedings will find them fully reported in the *Dundee Advertiser* of Monday, 16th inst.

Redistribution of Population.—Mr. Frank W. Merrick, of 122, Beach Street, Roslindale, Mass., writes to the New York *Electrical Review* to say that he is gathering data regarding the effect of the telephone and the electric street railway upon the redistribution of population now going on between city and country, and the effect of these agencies upon the rural districts. He wants to be directed to sources of reliable information.

Electric Launch.—Mr. W. Bowen, of the Eel Pie Launch Building Works, Twickenham, has just completed for H.M. the King of Portugal, an electric launch designed for use on the sea. The craft is 28 ft. long, 6 ft. 6 in. beam. and when loaded with full complement of 25 passengers draws 2 ft. of water. A battery of 24 large accumulators will suffice for a run of 100 miles at 4 knots.

The Double Fatality.—On 13th inst. the inquest was held at Jarrow on the bodies of Peter Kelly, 38, and Joseph Keenan, 35, labourers, who were killed by electricity at Messrs. Palmer's works on Tuesday last week. The two men were found dead in the electric motor house, where, it was stated, they had no business to be. Arthur Ward, electrician at Palmer's works, said the voltage in the motor house was 410. The man who worked the motor knew of the danger, and took the necessary precautions. It was not a trap for the unwary, as the men would have to go on their hands and knees to get to the switchboard. There was nothing to show how the men got the shock, but it was possibly the outcome of curiosity. Probably, after one got caught, the other went to help him. The electric plant had not been started when the men had gone to the house, and therefore they must have set the current in operation. If the men had been found a few minutes after the occurrence, they might have been brought round. The jury found verdicts of "Accidental death."

The Manufacture of Aluminium and Sodium.—An English patent (No. 9,676, May 9th, 1901) has recently been granted to A. H. Cowles and the British Aluminium Company for a process in which sodium aluminate and carbon are heated by electrical agency in a closed furnace, one wall of which is pervious to gases. The sodium is reduced from its compound, and passes as vapour through the furnace into an outside chamber, where it is condensed and collected. The aluminium is also reduced, and forms a carbide with the carbon of the charge. An alloy of aluminium with any non-volatile metal may be won in a similar manner by incorporating some compound of that metal with the furnace charge; while if some volatile metal is also used, an alloy of sodium with the volatile metal is found in the condensing chamber. The specification describes a suitable furnace for the operations above outlined.

Personal.—Mr. A. S. E. Ackermann, who has been absent over four months, has just returned from the United States, where he has made a careful and extended study of coal mining by machinery, the reports on which are now appearing in the technical press.

Mr. W. J. Poole, station superintendent, Glasgow Corporation Electricity Department, left for the United States the week before last, for the purpose of studying the American practice in electrical undertakings. He will be absent for a month, and will visit New York, Pittsburg, and many other important centres of electrical industry.

On the occasion of the approaching departure for the Transvaal, to take up appointments under the new Government of that Colony, of Messrs. T. T. Hardaker (telegraph engineer) and C. Long (controller of telegraphs) those gentlemen were lately entertained by their colleagues of the Maritzburg (Natal) Post Office to a farewell banquet. Mr. J. Frank Brown presided, and at the close of the proceedings, incidentally remarked that their reunion that evening had been so successful that he thought they ought to have a postal and telegraph dinner annually. The guests of the evening received a number of valuable gifts from their sometime colleagues.

Mr. Herbert Broadbent, M.I.E.E., manager of the electricity department of Perth Gas Company (West Australia), is in England for the purpose of buying additional machinery; he will also inquire into the possibility of employing producer gas-driven plant.

Mr. L. Carter, of Leicester, has been appointed electrician to the Colwyn Bay Urban Council.

Mr. Ivon Braby, A.M.I.E.E., has been appointed lecturer in electrical engineering at the Crystal Palace School of Practical Engineering.

Mr. A. Randall Bell has just resigned the position of chief assistant at the Swansea Corporation electricity works in order to become resident engineer to the Uxbridge and District Electricity Supply Company.

On Thursday last week, in the offices of Messrs. J. H. Holmes & Co., electrical engineers, Portland Road, Newcastle, Mr. Frank Broadbent, chief superintendent engineer, who has been with the firm for 12 years, was presented with a splendid secretaire in Spanish mahogany. The presentation was made on behalf of the staff by Mr. Brown, the chief designer, and numerous testimonies were given of the ability of Mr. Broadbent, as well as of his cordial relations with all. Mr. Broadbent, who is leaving to take up a consulting practice in London, was also the recipient of a very handsome cheque from the principals. Mr. Broadbent feelingly responded.

Last week Mr. Woodman, chief engineer to the Dover Electricity Supply Company, entertained the staff and employés of the works to dinner in honour of his approaching marriage. Mr. Woodman was the recipient of a handsome silver tantalus.

The Motorcar v. The Tramcar.—Colonel Crompton's address to the Engineering Section of the B.A., which we abstract on another page of this issue, should be read in conjunction with a thoughtful letter from the pen of Mr. J. Clifton Robinson, of the London United Tramways Company, appearing in yesterday's *Times*. The former may be styled a chimerical suggestion from the realms of prophesy; the latter a contribution from the world of actual practice. At Young's Corner the electric cars can carry 8,400 passengers per hour in one direction, against 4,000 stated by Col. Crompton as the maximum carrying capacity of tramways. The letter affirms that the solution of present-day traffic problems lies in the electric tram and the tube. "The *future* may be with the motorcar, and the specially constructed alternative main road; it may, on the other hand, be with the flying machine." We surmise that most of our readers who are connected with the electrical industry will feel inclined to back the tram against the automobile for some years to come.

Marriage.—On the 17th inst., at the Parish Church, Hampstead, Mr. Selwyn Seafield Grant, of the British Electric Traction Company, Limited, was married to Mary Christian, daughter of John Spencer Curwen.

Coal Consumption in Power Stations.—The following communication comes to hand too late for inclusion in our "Correspondence" columns :—

"With further reference to the estimated 3 lbs. of coal per unit mentioned by the President of the Institution of Electrical Engineers, and the figures given by your correspondent 'W. H. J.,' the writer is of opinion that 3 lbs. of coal per unit is a very reasonable expenditure in a properly designed power station with a fairly high load factor.

"The 2·1 lbs. mentioned by your correspondent 'W. H. J.' is certainly very good for any British power station. In the writer's experience of two modern tramway power stations with a load factor of 50 to 53 per cent., the coal consumption per unit generated averages 3·4 and 3·5 lbs. respectively. This expenditure includes the coal consumed in keeping banked fires in reserve boilers.

"F. E. Yerbury, A.M.I.E.E.

"Sheffield, *September 18th*, 1901."

The results which Mr. Yerbury and our other correspondents have brought forward this week are more in accord with expectation, but are still sufficiently remarkable. Assuming the highest possible efficiencies for the engines and dynamos at normal *full* load, 1 KW.-hour corresponds with 1·6 I.H.P.-hours. Hence, allowing 1·25 lbs. of coal per I.H.P.-hour, which is about the lowest consumption attained in practice, the minimum consumption of coal that can possibly be hoped for is 2 lbs. per unit. Again, taking 18 lbs. of steam per unit as practically the best result recorded, and assuming the high figure of 9 lbs. of water evaporated per lb. of coal, we once more arrive at 2 lbs. of coal per unit—under the *best* conditions. Yet, according to "W. H. J.," this figure is very nearly realised in practice, with a load factor of 55 per cent.! We await further communications with interest, and we should be glad if our correspondents would kindly state *exactly* what they mean by "load factor."

Appointments Vacant.—Twenty-eight applications have been received by the Dewsbury Corporation for the position of electrical engineer; seven candidates have been invited to appear before the Committee. An electrical engineer and manager is wanted by Southampton Corporation at £500 per annum. A demonstrator in electrical engineering is wanted for Nottingham University College at £200 to £250. A borough electrical engineer is wanted for Hackney at £400 per annum. An electrical engineer is required for the Public Works Department at Jamaica at £500 per annum for three years.

Obituary.—We regret to learn, just as we go to press, of the death of Mr. W. T. Goolden, at the age of 52 years, heart failure being the cause. The funeral was to take place yesterday (Thursday) at Maidenhead. Mr. Goolden, through his long connection with the electrical engineering industry as Goolden & Trotter, and W. T. Goolden & Co., made himself many friends among our readers.

Municipality v. Power Supply Company.—Some time ago we drew attention to a report in which Mr. Mordey advised the Corporation of Newcastle-upon-Tyne to acquire the electricity supply companies' undertakings in that city, as owing to the state of transition in which they were —and are—no more favourable opportunity was ever likely to occur. The Corporation consequently threw every possible obstacle in the way of the Newcastle-upon-Tyne Electric Supply Company, Limited, which was seeking important powers for the purpose of reorganising its system of supply and combining it with the immense scheme of power transmission and distribution which was recently brought to a successful issue. For this purpose the Corporation sought the aid of the Board of Trade, whose tender regard for municipal authorities is well known. We are pleased to note, therefore, that the Board of Trade, after careful consideration, has entirely disregarded the opposition of the Corporation, and has approved of the whole scheme of the Electric Supply Company as originally proposed. We hail this decision as an unmistakable indication that the Board is fully awake to the immense importance to the nation of well-organised and wide-spreading schemes of electric power supply, and we look forward hopefully to its future action with regard to the removal of the onerous restrictions which at present hamper the development of these undertakings.

NEW COMPANIES REGISTERED.

Leeds, Wakefield, Dewsbury and District Electric Tramways, Limited (71,333).—This company was registered on September 10th, with a capital of £100 in £1 shares, to undertake the construction, maintenance and working of tramways, light railways, electrical and other railways and motors therefor, and to carry on the business of builders of and dealers in all kinds of vehicles drawn or propelled by animal traction or otherwise, producers and suppliers of electricity for the purposes of light, heat or power, india-rubber manufacturers, makers of and dealers in tyres for cycles and vehicles, &c. The first subscribers (each with one share) are:—W. Everist, the Saracen's Head, Ware Road, Hertford, publican; L. H. Kohler, Aynho House, Dalston, N.E., secretary; G. C. A. Kohler, Aynho House, Dalston, N.E., merchant; D. J. Norris, 61, London Street, Fitzroy Square, W., clerk; R. H. Ward, 46, Fetter Lane, E.C., physician; A. T. Pendry, 3, Manor Place, Hackney, registrar; and E. C. Penford, 40, Holborn Viaduct, E.C., secretary. No initial public issue. Registered without articles of association.

Pollard Electrical Engineering Company, Limited (71,342).—This company was registered on September 11th, with a capital of £5,000 in £5 shares, to take over the business of electrical and mechanical engineers now carried on at Hyde, Cheshire, as "Stanley, Davies & Pollard," to carry on the business of an electric light, heat, and power supply company, and to manufacture and deal in cables, wires, lines, accumulators, lamps, electrical apparatus and machinery, &c. The first subscribers (each with one share), are:—J. Bailey, 31, Kensington Street, Hyde, currier; J. Pollard, 35, Perrin Street, Hyde, electrical engineer; Mrs. B. Pollard, 35, Perrin Street, Hyde; R. Pollard, 35, Perrin Street, Hyde, electrical engineer; E. Hibbert, 29, Princess Street, Manchester, estate agent and accountant; C. H. Brogden, 8, Reynold Street, Hyde, auctioneer and valuer; and A. H. Gibbings, 12, St. John's Lane, Liverpool, electrical engineer. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are James Pollard, Richard Pollard, and Edwin Hibbert; remuneration as fixed by the company. Registered office, Mary Street, Hyde, Cheshire.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Column Printing Telegraph Syndicate, Limited (29,493).—This company's annual return was filed on August 22nd, when 289 shares were taken up out of a nominal capital of £25,000 in 500 shares of £50 each. The full amount has been called up on 189 shares and £8,940 has been paid, leaving £710 in arrears. £5,000 is considered as paid up on the remaining £100 shares. No mortgages or charges.

Chili Telephone Company, Limited (29,252)—This company's annual return was filed on August 28th, when 44,000 shares were taken up out of a nominal capital of £250,000 in 50,000 shares of £5 each. £220,000 has been paid. Mortgages and charges, £56,000.

British Electric Transformer Manufacturing Company, Limited (57,293).—This company's annual return was filed on September 5th, when 40,000 shares were taken up out of a nominal capital of £50,000 in £1 shares. £1 per share has been called up on 20,000 and £20,000 has been paid. 20,000 shares are considered as fully paid. No mortgages or charges.

British Continental Electricity Company, Limited (57,088).—This company's annual return was filed on September 2nd, when 1,000 preference and 892 ordinary shares were taken up out of a nominal capital of £20,000 in 1,000 preference and 1,000 ordinary shares of £10 each. £10 per share has been called up on 790 preference and 707 ordinary, and £5 per share on 35 ordinary shares, resulting in the receipt of £15,145. £3,600 is considered as paid on 210 preference and 150 ordinary shares. No mortgages or charges.

Jandus Arc Lamp and Electric Company, Limited (43,898).—This company's annual return was filed on September 11th, when 2,041 shares were taken up out of a nominal capital of £30,000 in 3,000 shares of £10 each; £5 per share has been called up on 1,195, and £10 per share on 250 shares, resulting in the receipt of £8,476; 596 shares are considered as fully paid. Mortgages and charges, £7,094 4s. 7d.

Exchange Telegraph Company, Limited (6,152 C).—This company's annual return was filed on August 14th, when 8,023 "A" and 16,200 "B" shares were taken up out of a nominal capital of £246,250 in 8,125 "A" and 165,000 "B" shares of £10 each; £9 per share has been called up on 6,000 "A" and £1 per share on 2,023 "A" shares, resulting in the receipt of £56,023; £179,000 considered as paid, being £162,000 on 16,200 preference shares and £17,000 on 2,125 "A" shares credited with £8 paid. No mortgages or charges.

SUPPLY STATION ACCOUNTS.

Sunderland Corporation Electricity Accounts.

The accounts just issued by the Corporation of Sunderland covering the operations of the electricity undertaking for last year are very satisfactory, and indicate substantial progress in all directions. The capital expenditure covers the provision of traction generators and plant in connection therewith, and the initial costs of the buildings and machinery for the new station on the Hylton Road site, to which we referred when dealing with the accounts of 1899. That this station is a necessity is shown by the Dunning Street works being fully occupied, and Mr. J. F. C. Snell, the engineer for both general supply and the traction scheme, hopes to have the new plant available for the coming winter demand, while he foreshadows in his yearly report the construction of a third generating station on the other side of the river.

General Statement.

	1899.	1900.	Inc.
Total capital expenditure ...	£83,747	**£122,433**	£38,686
Number of units sold	640,079	**1,218,768**	578,689
No. of lamps connected.. ...	35,024	**50,092**	15,068
Maximum load in KW.	682	**1,114**	432
Gross revenue	£9,804	**£16,526**	£6,722
Gross expenditure...	£5,757	**£9,272**	£3,515
Gross profit	£4,047	**£7,254**	£3,207
Average price per unit sold ...	3·50d.	**3·18d.**	−·32d.

The receipts from sale of energy stand at just under 3⅝d., a figure which maintains the reputation of Sunderland for a cheap supply to the public, and taking total receipts the return of 3¼d. is third in the list of English towns, being beaten only by Nottingham and Manchester.

Revenue Statement.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£9,338	3·50d.	**£16,164**	3·18d.	−·32d.
Meter rents	272	·10d.	**331**	·06d.	−·04d.
Sale of lamps, &c.	162	·06d.	**1**	·00d.	−·06d.
Sundry rents, &c.	32	·01d.	**30**	·01d.	·00d.
Gross revenue ...	£9,804	3·67d.	**£16,526**	3·25d.	−·42d.

In the costs sheet, salaries and wages taken together have fallen nearly ¼d., repairs have dropped by about half this amount, while oil, waste, &c., and establishment charges show slight downward changes; coal, as might be expected, has not quite maintained the old figure, and rates and taxes have been increased owing to the extensions, but notwithstanding these latter, the works costs have been improved by nearly ⅛d., and total costs by no less than ⅛d., resulting in the former being reduced to nearly 1⅛d., and the latter well below 2d. per unit.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal	£2,027	·76d.	£4,190	**·83d.**	+·07d.
Oil, waste, water and engine room stores.	281	·10d.	422	**·08d.**	−·02d.
Salaries and wages incurred in generation and distribution, and attending public lamps.	1,072	·40d.	1,551	**·30d.**	−·10d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	715	·27d.	751	**·15d.**	−·12d.
Works costs ...	£4,095	1·53d.	£6,914	**1·36d.**	−·17d.
Rent, rates and taxes ..	320	·12d.	721	**·14d.**	+·02d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	954	·36d.	1,155	**·23d.**	−·13d.
General establishment charges, stationery and printing, law charges and insurance	388	·15d.	482	**·10d.**	−·05d.
Other expenses	—	—	—	—	—
Total costs ...	£5,757	2·16d.	£9,272	**1·83d.**	−·33d.

With net profits of four figures, we hope to see a reserve fund account opened, and some provision made for depreciation. The gross profit last year was £3,207 more than in 1899; against this was an increase in financial charges of £2,417; the difference of £790 was added to the net profit, bringing the £467 of 1899 up to £1,257 last year. How this was appropriated does not appear in the accounts.

Mr. Snell shows in his report that the gross profit was equal to no less than 7 per cent. upon the capital outlay.

Profit Statement.

	1899.	1900.
Interest on loans	£1,756	£2,974
Sinking fund for repayments	1,824	3,023
Net profit carried to rates	467	—
Net profit carried forward	—	1,257
Gross profit	£4,047	£7,254

Islington Borough Council Electricity Accounts.

The accounts of the Islington undertaking are the first issued as a Metropolitan Borough Council, and cover a period of 15 months, which renders comparison with any preceding year a difficult matter. The net result of the working is a deficiency of over £1,000. Heavy capital expenditure on works and extensions so far only partially productive of revenue explains much; other factors tending to produce the result are also mentioned below. There is no doubt that delays in obtaining the delivery and completion of plant have held back the revenue-earning capacity of the station, but the policy of the Council now seems to be more favourable towards its electricity undertaking, and with reduced charges for power, the results should be considerably improved.

General Statement.

	1899. 12 months.	1900. 15 months.	Inc.
Total capital expenditure ...	£259,562	**£322,334**	£62,772
Number of units sold	1,346,437	**2,324,057**	977,620
Total maximum load	1,080	**1,419**	339
Gross revenue	£25,354	**£42,425**	£17,071
Gross expenditure	£15,833	**£29,567**	£13,734
Gross profit	£9,521	**£12,858**	£3,337
Average price per unit sold ...	4·43d.	**4·31d.**	−·12d.

The rates charged remain at 7d. and 4d. for general supply, but the figure of 3½d. for power has been reduced 2d. The price per unit for street lighting is 3½d. per unit, which includes all charges for the provision and maintenance of the public lighting, mains, lamps and columns. As Mr. Albert Gay, the borough electrical engineer, mentions in his report, the financial result will be very different when the output for private supply bears a reasonably high percentage to the total output. At present this cannot be said to be the case:—

	Private supply. Units.	Private supply. Revenue.	Public lighting. Units.	Public lighting. Revenue.	No. of public arc lamps.
1899 ...	686,225	£15,254	660,212	£9,628	330
1900 ...	1,188,821	£25,259	1,135,236	£16,556	398

The revenue per unit has fallen slightly, but still works out well over 4d. The increase in output from the commencement of supply is shown by these figures, which bear evidence of the need for extra generating plant:—

Year.	Total units sold.	Increase over previous year. Units sold. No.	Units sold. Per cent.	Revenue. Amount.	Revenue. Per cent.
1893 ...	298,000	—	—	—	—
1897 ...	504,000	206,000	69	£4,716	62
1898 ...	911,000	408,000	81	£9,021	73
1899 ...	1,346,000	435,000	48	£4,090	19
1900 (15 months)	2,324,057	No useful comparison.			

Revenue Statement.

	1899. 12 months. Gross	1899. 12 months. Per unit.	1900. 15 months. Gross.	1900. 15 months. Per unit.	Inc.
Sale of energy	£24,835	4·43d.	**£41,744**	4·31d.	−·12d.
Meter rents	382	·07d.	**581**	·06d.	−·01d.
Sale of lamps, &c.	—	—	—	—	—
Rent received and bank interest	105	·02d.	**100**	·01d.	−·01d.
Sundry fees	32	·00d.			
Gross revenue ...	£25,354	4·52d.	**£42,425**	4·38d.	−·14d.

The average price of coal in 1899 was 17s. 1d. per ton, and for the later period 23s. 5d., or an increase of 6s. 4d. per ton, which represents £3,687 on the working costs and over which the engineer had no control. An additional expenditure of £2,000 was also incurred outside the works for street lighting. Coal per unit has run up to 1⅜d., an increase of ⅜d.; repairs and salaries have also slightly risen,

the latter principally owing to the action of the London County Council in refusing consent to items in loans covering superintendence, &c., of permanent officials upon new works. The total costs are now just over 3d., but Metropolitan are different from provincial conditions and tend towards high costs.

COST OF PRODUCTION.

	1899. 12 months. Gross.	Per unit.	1900. 15 months. Gross.	Per unit.	Inc.
Coal	£5,707	1·02d.	£13,633	1·408d.	+·388d.
Oil, waste, water, carbons, and engine room stores.	1,820	·32d.	3,034	·313d.	−·007d.
Salaries and wages incurred in generation and distribution and attending street lamps	4,062	·73d.	5,551	·573d.	−·157d.
Repairs and maintenance of engines, boilers, dynamos, &c., and repairs of public lamps.	1,254	·22d.	2,338	·242d.	+·022d.
Works costs	£12,843	2·29d.	£24,556	2·536d.	+·246d.
Rent, rates and taxes ..	820	·15d.	1,435	·148d.	−·002d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	1,365	·24d.	2,410	·249d.	+·009d.
General establishment charges, stationery and printing, law charges and insurance.	732	·13d.	1,128	·116d.	−·014d.
Other expenses: repairs to property	73	·01d.	38	·004d.	−·006d.
Total cost ...	£15,833	2·82d.	£29,567	3·053d.	+·233d.

The financial charges are high and show an increase of £4,744, of which only £3,337 were provided by enhanced gross profits. This difference of £1,407 caused the profit of 1899 to disappear and left a net loss of £1,027. With a larger output these figures should again show that the undertaking can meet all charges against it.

PROFIT STATEMENT.

	1899. 12 months.	1900. 15 months.
Interest on loans, deposits and overdraft ..	£6,568	£9,099
Sinking fund for repayments	2,573	4,786
Net profit carried forward	380	−1,027
Gross profit	£9,521	£12,858

Aberdeen Corporation Electricity Accounts.

THE accounts of the electricity supply undertaking, up to the end of the month of July last for the preceding period of 12 months, of the Aberdeen Corporation have recently been issued, and show results of a similar character to those which frequently appear in this column. The period covered has been one of general activity, owing to the amount of new works in progress. A year ago the Dee Village property had been acquired, and a start made in pulling down the existing buildings and preparing for the new power house. The temporary engine room at these Ferryhill works has now been completed, and the plant is well forward. The temporary arrangements will cause the working, however, to be rather inefficient, and the increase in interest and sinking fund upon partially unremunerative capital will burden the accounts.

GENERAL STATEMENT.

	1899—1900.	1900—1	Inc.
Total capital expenditure (less depreciation)	£85,366	£114,503	£29,137
Number of units sold	846,012	1,199,913	353,901
No. of 33-watt lamps connected ...	—	79,663	—
Gross revenue	£14,553	£18,941	£4,388
Gross expenditure...	£5,946	£9,550	£3,604
Gross profit	£8,607	£9,391	£784
Average price per unit sold ...	3·91d.	3·66d.	−·25d.

The prices charged are 6d. and 3d. for private supply and 3d. and 1d. for motive power. Notwithstanding the somewhat difficult conditions of working, Mr. J. Alex. Bell has recommended that these charges be allowed to remain in force, and further, that the price for public lighting be reduced to 6d. and 2d. The charge for maintenance, carboning, &c., of the harbour lamps he suggests should be fixed at £5 per lamp yearly.

REVENUE STATEMENT.

	1899—1900. Gross.	Per unit.	1900—1901. Gross.	Per unit.	Inc.
Sale of energy	£13,787	3·91d.	£18,286	3·66d.	−·25d.
Meter rents	—	—	—	—	·00d.
ire of motors, sale of lamps and attendance on harbour and other lamps	309	·09d.	625	·12d.	+·03d.
Sundry guarantees, &c. ..	457	·13d.	30	·01d.	−·12d.
Gross revenue ...	£14,553	4·13d.	£18,941	3·79d.	−·34d.

The most important change in the cost sheet is the rise in coal per unit by the sum of ¼d. This is equal, but opposite in direction to the difference in the average price received, so that the department suffers by no less than ½d. by these changes taken together. Owing to trouble with smoke, the coal now used is of a lower calorific value than formerly. The heavier repairs are partly explained by the additional labour expended in maintaining the copper strip mains laid in culverts in the centre of the town and replacement of rubber-insulated service lines.

COST OF PRODUCTION.

	1899—1900. Gross.	Per unit.	1900—1901. Gross.	Per unit.	Inc.
Coal..	£2,428	·69d.	£4,698	·94d.	+·25d.
Oil, waste, water and engine room stores	296	·08d.	384	·07d.	−·01d.
Salaries and wages incurred in generation and distribution.	932	·27d.	1,146	·23d.	−·04d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	778	·22d.	1,237	·25d.	+·03d.
Works cost ...	£4,434	1·26d.	£7,465	1·49d.	+·23d.
Rent, rates and taxes ..	740	·21d.	797	·16d.	−·05d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	360	·10d.	430	·09d.	−·01d.
Establishment charges, stationery and printing, law charges and insurance	373	·11d.	553	·11d.	·00d.
Other expenses, compensation and special repairs	39	·01d.	305	·06d.	+·05d.
Total costs ...	£5,946	1·69d.	£9,550	1·91d.	+·22d.

Owing to the various causes already referred to, the increase in gross profit only amounts to £784, whereas the financial charges absorb an additional £869. The difference of £85 has reduced the net profit to £4,842, of which £2,673 is allocated to the depreciation account and £2,169 to the reserve fund. The sound policy adopted of building up these two funds is one which might well be followed elsewhere.

PROFIT STATEMENT.

	1899—1900.	1900—1901.
Interest on loans	£2,344	£2,842
Sinking fund for repayments	1,336	1,707
Net profit carried to depreciation account	2,439	2,673
„ „ reserve fund	2,284	2,169
„ forward	204	—
Gross profit	£8,607	£9,391

CITY NOTES.

Electric Railway and Tramway Carriage Works Co.

THE report of the directors for the year ended June 30th last, to be submitted to the meeting to be held at Preston on the 26th inst., says that the directors are pleased to state that the output of cars mentioned in the prospectus has been greatly exceeded, the works are fully employed and the prospects of new work are satisfactory. The works have been fully maintained as regards buildings and machinery, the cost of which has been charged against revenue. After placing £4,000 to a depreciation fund the profit for the year is £21,206, to which must be added £3,914 brought from last year, making a total of £25,120. The directors recommend that this amount be dealt with as follows:—To write off expenses incurred to June 30th, 1899, £7,342; to carry to a general reserve fund, £2,000; to pay a dividend of 8 per cent. for the year, £12,000; to carry forward £3,778. The directors beg to state that extra capital is required for the increased business of the company. They, therefore, intend issuing debentures to the amount of £50,000, for which the shareholders will have the preference in subscribing.

Prospectus.

THE prospectus of Accumulator Industries, Limited, is now in private circulation, and we have been asked by the secretary to mention its main features. Of the nominal capital of £40,000 (20,000 £1 ordinary and 4,000 7 per cent. £5 preference), only 2,000 of the preference are now offered for subscription, £10,000 ordinary having already been issued. The present issue is intended "to provide for purchase of further patents, extensions to the factory and for working capital, &c." The object of the company is to manufacture accumulators, controllers, motors, and electrical vehicles of every description. The Leitner accumulator is the main feature intended for light automobile and launch traction work, intermediate traction accumulators, and batteries for central station and private lighting installations. It is *estimated* by the Edinburgh agents of the company that at least £5,000 worth of business in the accumulators will be done in Scotland during the year. The works at Woking (now rented at £150 per annum) are insufficient to cope with the present demand, but happily there is plenty of room for extensions and when an additional assembling

room has been erected (cost £800), the capacity will be 20 batteries per week, such batteries being estimated to sell at £80 each. One "provisional arrangement" for 1,200 batteries per annum at £60 per battery has been entered into. The company will purchase from Electrical Undertakings, Limited, Leitner patent rights and assets connected therewith. The successful runs of the "Powerful" car are referred to in the prospectus. Henry Leitner is the vendor, and the purchase price is £5,000 in fully paid shares; he will also receive a minimum of £400 per annum (and 5 per cent. of net profits) for services rendered as managing director. He also intends leasing the Woking premises to the company. The directors are:—H. Leitner, Berthold Kuettner, and A. Thompson, M.I.E.E. The offices are at 14, Silver Street, Bloomsbury (secretary, F. W. Manley). The list is stated to close on Friday next, September 27th. Considering that nothing is stated as to the business (profitable or otherwise) done in the year since the company's formation, that no value is stated for the Woking works equipment, and that little is known of the battery beyond the fact that it has enabled good trial runs to be made, we must confess that we do not at present see our way to recommend the above issue as a desirable investment.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to—Crompton & Co., Limited.—Further issue of 31,000 shares of £3 each, fully paid, Nos. 54,001 to 85,000. The Committee has further been asked to allow the following securities to be quoted in the Official List:—Waygood (R.) & Co., Limited—35,000 vendors' ordinary shares of £1 each, fully paid, Nos. 1 to 35,000; and 35,000 vendors' 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 35,000. The Committee has ordered the undermentioned securities to be quoted in the Official List:—British Electric Traction Company, Limited—Further issue of 30,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 160,001 to 190,000. Parker (Thomas), Limited—7,500 shares of £5 each, fully paid, Nos. 1 to 7,500.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending Sept. 13th were £583; corresponding week last year, £511; increase, £72. Total to date, £18,412, corresponding period last year, £16,599; increase, £1,813. Miles of track open, 8¾.

Blackpool and Fleetwood Tramways.—The receipts for the week ending September 14th were £1,234; corresponding week last year, £1,329; decrease, £95. Total receipts to date, £15,946; corresponding period last year, £15,850; increase, £96.

Bristol Tramways and Carriage Company.—The receipts for the week ending September 13th were £4,911; corresponding period last year, £3,688; increase, £328.

Central London Railway.—The receipts for the week ending September 14th were £5,658; corresponding week last year, £4,833; increase, £825. Total receipts from July 1st (11 weeks), £62,217. Miles open, 6.

City and South London Railway.—The receipts for the week ending September 15th were £1,836; corresponding week last year, £1,506; increase, £330. Total from July 1st to date, £20,230; corresponding period last year, £16,528; increase, £3,702. Miles open, 4¾.

Dover Corporation Tramways.—The receipts for the week ending September 14th were £276 11s. 2½d.; corresponding week last year, £275 15s. 2½d.; increase, 16s. Total to date, £8,144 8s. 9½d.; corresponding period last year, £7,692 4s. 6½d.; increase, £452 4s. 3d. Miles of track open, 3. Car miles run, 1901, 5,338; 1900, 5,188. Number of cars, 1901, 11; 1900, 11.

Dublin United Tramways Company.—The receipts for the week ending September 13th were as follows:—D.U.T. Co., electric cars, £3,794 4s. 0d.; D.S.D. Co., electric cars, £965 9s. 4d.; total, £4,762 13s. 4d.; corresponding period last year—D.U.T. Co., electric cars, £3,639 5s. 3d.; ditto, horse cars, £29 2s. 8d.; D.S.D. Co., electric cars, £1,079 0s. 1d.; total, £4,947 8s. 0d.; decrease, £184 14s. 8d.; aggregate to date, £56,790 12s. 2d.; aggregate to date last year, £55,835 4s. 5d.; increase, £1,455 7s. 9d. The mileage worked is 45 miles electrically, as against 42 miles electrically, and two miles by horses, for the corresponding period last year.

Glasgow Corporation Tramways.—Receipts for week ending 14th inst., amounted to £13,706 7s. 10d.; compared with £9,933 18s. 2d. for same period last year. This amount beats the last record by some £270. The aggregate since present financial year commenced, June 1st, amounts to £187,434 9s. 5d., compared with £143,813 9s. 6d. for same period last year.

Liverpool Overhead Railway.—The receipts for the week ending Sept. 15th were £1,607; corresponding week last year, £1,719; decrease, £112. Total from July 1st to date, £18,966; corresponding period last year, £19,206; decrease £204. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The action of the Stock Exchange Committee in closing the House on Thursday as a mark of sympathy with the American people met with the entire approval of members, and the loss of a day's business was quietly accepted. Naturally, the closed days affect trade on others, and the influence of a holiday is often traceable throughout a whole week. The terribly sad event of last Saturday has, to some extent, retarded the volume of orders, but, so far as market movements are concerned, there has been a smart recovery from the fall which seized the Stock Exchange upon the first serious indications of ill from Buffalo. It might be fairly said that markets have recovered their normal state. Of course, there was no real reason why the death of President McKinley should have depressed quotations, but in times of excitement the Stock Exchange is not ruled by reason. Now that the situation has been faced, things are going on, even in the Yankee market, much in their usual way.

Pronounced ease still continues the prime factor in the Money Market, and investment stocks, on the whole, are well supported. There is considerable demand for anything of a high-class description which pays 4 per cent., and brokers experience some difficulty in finding suitable securities. An excellent stock of this class is the comparatively new Central Electric 4 per cent. Debenture, which is standing at 102 for the fully-paid issue. The return is all but 4 per cent. Rather more expensive is Charing Cross and Strand 4 per cent. Debenture stock, which cannot be obtained under 104. But the security is well-nigh irreproachable. At about the same quotation stands that similar stock, the Kensington and Knightsbridge and Notting Hill Electric 4 per cent. Debenture stock. These make a trio of high-class investments, paying a shade less than 4 per cent., and without multiplying examples, we may add the 5 per cent. Perpetual Debenture stock of the British Electric Traction Company. At 125 the stock yields exactly 4 per cent. to a buyer, and it can be purchased at a little less than this price, free also of stamp and fee. Chelsea 4½ per cent. Debenture has risen a point this week, and it now looks fairly valued. Metropolitan 3½ per cent. Debenture stock is short of the slight rise we recorded last week, but the 4½ per cent. stock is the turn harder.

British Electric Traction Ordinary are 5s. better, the market receiving some of that spasmodic attention which renders dealing in the shares a matter that requires great caution. Without arrogating any credit to ourselves, we may be glad that the Stock Exchange Committee have at last granted the quotation to the new British Electric Traction Preference for which we cried last week. The shares will now rank in every respect with the Preferences hitherto quoted in the Official List. The new Electric Construction shares are being similarly treated, and are now equal to the other Electric Constructions of the first issue.

In the telegraph market Eastern Extensions are good, buying being stimulated by the yields of nearly 5 per cent., which buyers can obtain from the shares. We may mention, in passing, that a printer made us responsible for a funny mistake last week in writing about Eastern Extensions. By cutting a clause into halves, we were made to quote "Chinas" at half-a-sovereign! Eastern Telegraph Company stocks display weakness, partly at the prospect of the competition to which we lately alluded. The 4 per cent. Debenture stock is down 2 points, and, compared with some of the kindred securities in the electrical supply list, it must be confessed that the latter are either too low, or that the former is too exalted. Anglo-American stocks are firm, the Deferred at a small rise, in consequence of the business that the company has had thrust upon it owing to the death of Mr. McKinley. The American Companies' stocks have failed to respond, but Western Telegraph shares have advanced ¼ for the same sad reason as Anglo "A." We noticed that the cabled gratitude for sympathy from the Philadelphia Stock Exchange to its London brother came over the wires of the Western Union Company.

National Telephone Ordinary are very dull upon the imminent approach of Government competition, and the fact that no definite statement has been made regarding the outcome of the *pourparlers* between the company and the Government is not reassuring to timid shareholders.

The railway market shows little alteration beyond a slight weakening in City and South London. They are talking about a dividend between 2 and 3 per cent. on "Twopenny Tube" Deferred for the current half-year, and 2½ would be regarded as satisfactory. The price is a point lower on the week. Discussing the company's stocks with a dealer in the market a day or two ago, we asked his opinion of the Preferred and Deferred. "I consider myself that the Preferred is a very good investment," he replied, underlining the remarks that have often been made in these columns of late, "but the Deferred you can only regard as a spec." The vibration question is said to have been satisfactorily settled.

Manufacturing shares are irregular in tone. British Westinghouse Preference are steady at 5¼, and the company appears to have plenty of work on hand. One of its last contracts is for the electrifying of the Mersey Railway. Sir Hiram Maxim shares are being dealt in at 21s. 6d. and thereabouts. Of provincial properties, the most interesting feature is that the recently issued 4½ per cent. Folkestone Electricity Supply Debenture was not all placed. Perhaps the remaining £10,000 may find its way into the market—who knows? Certainly the stock looks reasonably cheap at 102. Concerning reports, the Electric Railway and Tramway Carriage Company shows a remarkable advance upon last year's trading, but there is no market in the shares, and no price, dealing being a matter of negotiation.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations Sept. 11th.	Closing Quotation Sept. 18th.	Business done during week ended Sept. 18th. 1901. Highest.	Lowest
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	....
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	78 — 83	78 — 83	...	...
822,700£	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	53 — 56	53 — 56	55½	...
3,088,540£	Do. do. 6 % Pref	Stock	6 %	6 %	6 %	98 —100	98 —100	99½	99½
3,088,540£	Do. do. Deferred	Stock	18s. %	£1 7s.	5s. %	10½— 11	10⅝— 11¼	11	10 13/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	5 %	3½— 4	3½— 4	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	175 —185	175 —185	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	101 —103	102¼	...
16,000	Cuba Telegraph	10	8 %	7 %	...	5 — 6	5 — 6	5	...
6,000	Do. 10 % Pref.	10	10 %	...	...	13½— 14½	13½— 14½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	100 —104 %	100 —104 %	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½— 11½	10½— 11½	11¼	...
104,300£	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	143 —148	142 —147	145½	143
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	97 —100	96 — 99	99	97⅜
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	115 —118	113 —116	117	115†
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	14 — 14½	14 — 14½	14⅜	14⅛
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	115 —120	115 —120	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5¼%	...	100 —103	100 —103	100½	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104	101 —104 %	...	...
180,227	Globe Telegraph and Trust	10	5⅛%	5¼%	5⅛%	10½— 11	10⅜— 11¼	10 5/16	10 1/16
180,042	Do. do. 6 % Pref.	10	6 %	...	...	15 — 15½	15 — 15½	15 1/16	...
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	30 — 32	30 — 32	...	...
78,000£	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	41 — 45	41 — 45	42½	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	102 —105	102 —105	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	¼ %	5 %	...	⅝— 1	⅝— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅞— 4⅛	3⅞— 3⅞	...	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	12⅜	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅝ — 4¾	4⅝ — 4¾	4⅝	4 11/16
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	95 — 98	96¼	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	...	4 %	95 — 98	95 — 98	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	¾— 1	¾— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	...	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½	5 — 5½	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4¾— 5¼xd	4¾— 5¼	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	...	...
171,000	West African Telegraph, 5 % Debs.	100	...	...	...	99 —102	99 —102	...	..
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14 — 14½	14¼— 14¾	14½	14½
75,000£	Do do. 5 % Debs. 2nd series, 1906	100	...	...	...	102 —105	102 —105	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	5%	...	¼— ½	¼— ½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	...	...	...	5 — 6	5 — 6	5½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	...	...	...	3 — 5	3 — 5	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	101 —104 xd	101 —104	102	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7⅞— 8¼	7⅞— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref.	5	...	...	...	8¼— 8⅝	8¼— 8⅝	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10	9 — 10	9⅝	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅝	5¼— 5⅝	5 9/16	5⅜
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5½— 6	5½— 6	...	...
150,000£	Do. do. do. % Deb. Stock Red.	Stock	...	...	...	108 —111	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	6 %	4 %	0 %	8 — 9	8 — 9	8½	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	11½— 12½	11½— 12½	...	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	121 —126	121 —125	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	4 %	4 %	8 — 9	8 — 9	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13	12 — 13	...	...
200,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	103 —106 xd	103 —106	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5⅞— 6¼	5⅞— 6¼	6	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5½— 6	5½— 6	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	104 —107	104 —107	105½	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11 — 12 xd	11 — 12	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104 xd	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	96 —100	96 —100	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	13 — 14	13 — 14	...	...
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	111 —114	112 —115	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	98 —101	97 —100	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15 — 16 xd	15 — 16	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	15½	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½xd	8½— 9½	...	...
150,000£	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	97 —100 xd	97 —100	100	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90 xd	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 3	2 — 3	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	13 %	10½%	12 — 13	12 — 13	12⅝	12½

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of
Quotations on Liverpool Stock Exchange.
† Dividends paid in deferred share warrants, profits being used as capital
the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Sept. 11th.	Closing Quotation Sept. 18th.	Business done week ended Sept. 18th, 1901. Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7 — 8	7 — 8	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	89 — 93	89 — 93	...	...
45,000	British Electric Traction	10	6 %	8 %	9 %	14 — 14½	14 — 15	14½	14 7/16
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11¾ — 12¼xd	11¾ — 12½	12¼	12 1/16
350,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	122 —125	123 —126	124¾	124½
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	8 — 9	8 — 9	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5¼ — 5⅝	5¼ — 5⅝	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	...	8 %	⅞ — 1	⅞ — 1	...	...
50,000	¶ „ „ „ 6 % Cum. Pref.	£1	...	...	6 %	1 1/16 — 1 1/16	1 1/16 — 1 1/16	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅛ — 1⅜	1½ — 1⅝	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛ —	2 — 2⅛	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	102 —105	102 —105	...	...
108,710*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	99 —102	99 —102	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	15 — 16	15 — 16	...	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5⅝ — 6¼	5⅝ — 6¼	6⅛	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	110 —114	110 —114	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	...	102 —105	102 —105	104	103¼
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	...	105 —108	105 —108	107	106
440,100*l*	Do. do. Def. do.	Stock	...	...	...	99 —102	98 —101	99½	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	52 — 54 xd	51 — 54	53	51½
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	5¼ — 5⅝	5 — 5½	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	8 %	3½ — 3⅝xd	3½ — 3⅝	...	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —105	100 —105	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	2½%	¼ — ½	¼ — ½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	2½%	1½ — 2½	1½ — 2½	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	80 — 85	80 — 85	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	85 — 90	85 — 90	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1½ — 2	1⅝ — 2⅛	1 15/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2¼ — 2⅜	2¼ — 3⅛	...	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 —102 xd	98 —102	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9⅜ — 10⅛	9⅜ — 10¼	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	99 — 102	99 —102	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16½ — 17½	16½ — 17½	17⅛	...
35,000	Do. do. do. 4½ % Pref.	5	...	4½%	4½%	5½ — 6	5½ — 6	5⅞	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21½ — 22½	21½ — 22½	22⅛	...
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3⅜%	3½%	7½ — 7¾	7 — 7⅛	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13½ — 13¾	12⅜ — 13	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	19/- to 20/-	... — ...	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	38 — 42	38 — 42	40	38¾
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	104 —106	104 —106	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	12 %	10½ — 11½	10½ — 11½	11	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5¾ — 6¼	5⅝ — 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	92 — 95	92 — 95	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 1/-—3/-
National Electric Free Wiring, 17/6 paid, ½—¾.
* From Birmingham Share List.
¶ From Manchester Share List.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16.
Do. do. Pref. (£10 pd.), 10⅛—10¾.
*T. Parker, £10 (fully paid), 16½.

Bank rate of discount 3 per cent. (June 13th, 1901).

MARKET QUOTATIONS, Wednesday, September 18th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	80/-	80/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a „ „ ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£15	£15	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£22	£22	..
a Lead, Nitrate	per ton	£24	£24	..
a „ White Sugar	per ton	£31	£31	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8¼d.	8¼d.	..
a „ Caustic (75/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	80/-	80/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£3	£3	..
a „ Bichromate, casks ..	per lb.	2½d.	2½d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b „ Wire, in ton lots	per ton	£224	£224	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £140	£75 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c Tube (brazed)	per lb.	10d.	10d.	..
c „ „ (solid drawn) ..	per lb.	8¼d.	8¼d.	..
c „ Wire, basis	per lb.	7¾d.	7¾d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c „ „ (solid drawn) ..	per lb.	10½d.	10½d.	..
g Copper Bars (best selected) ..	per ton	£82 to £83	£82 to £83	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£82 to £83	£82 to £83	..
g „ Rod	per ton	£82 to £83	£82 to £83	..
e „ (Electrolytic) Bars ..	per ton	£83	£82	..
e „ „ Sheets ..	per ton	£90	£90	..
e „ „ Rod ..	per ton	£84	£84	..
e „ „ H.C. Wire ..	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/8½ to 3/9	3/8½ to 3/9½	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants) ..	per ton	45/8½	45/0½	8d. inc.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	50/- to 52/6	50/- to 52/6	..
i „ Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£12 5 to £12 7 6	£12 5 to £12 7 6	..
g „ „ Sheet	per ton	£13 5	£13 5	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9	£9	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p „ rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ „ strip & sheet	per lb.	From 1/8	From 1/8	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10½d. to 1/0½	10½d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i „ „ in bars		£58	£58	..
g Tin, block	per ton	£116 10 to £117 10	£116 10 to £117 10	..
g „ foil	per lb.	1/6	1/6	..
n „ wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£35 to £65	£35 to £65	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	..	..	..
j „ Best Flax, 6 lea.	per lb.	..	..	..
j „ Hemp, 8 ply 10 lbs. ..	per lb.	..	..	..
j „ „ Russian, 10 lbs. ..	per lb.	..	..	..
j „ Jute, 180 lbs. rove ..	per ton	..	..	..
k Zinc, Sh's. (Vielle Montagne bnd.)	per ton	£22 10	£22 10	..

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Jackson & Till. i Messrs. Bolling & Lowe.

Quotations supplied by { k Messrs. Morris Ashby, Limited m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company, Ltd.

THE INTERNATIONAL ENGINEERING CONGRESS OF 1901.

CONTINUOUS-CURRENT DYNAMOS.

(Abstract of Paper read before Section IX. by Henry A. Mavor, M.I.E.E.)

Some years' experience in dealing with the manufacture of continuous-current dynamos has led the writer to seek for a more definite basis of comparison for such machines than has hitherto been available. The value of a trustworthy basis of comparison need not here be insisted upon at any length, but the manufacturer who desires to standardise and systematise the production of his machinery, begins at the wrong end if he does not first systematise his methods of design so soon as his experience enables him to do so, and until he has systematised his design, the standardising of production must proceed on an unsatisfactory basis.

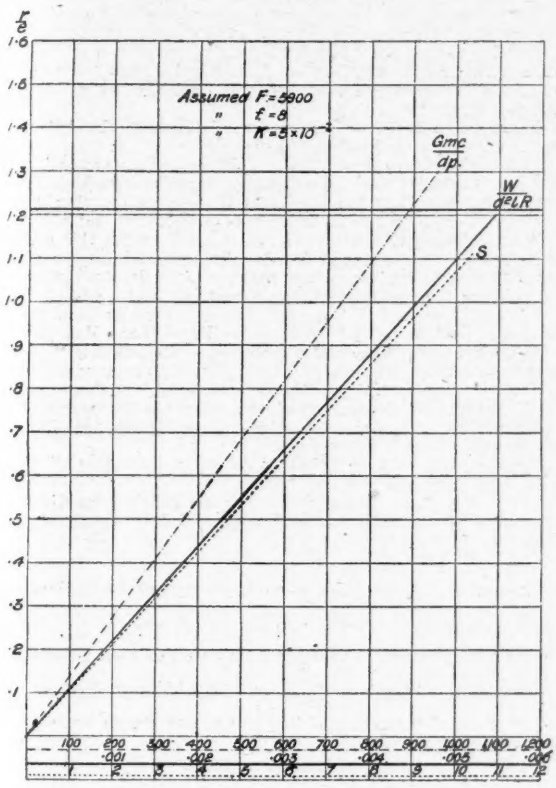


Fig. 1

The object of this paper is to put in simple mathematical form certain practical considerations in connection with dynamo design, and to use them for the systematic treatment of the subject on practical lines.

The parts of the subject proposed to be dealt with are sufficiently indicated in a list, which is alphabetically arranged for convenience of reference. The quantities dealt with are 17 in number. Certain of these are treated as constants, which may be fixed by the designer from the results of his experience. Others may be assumed or modified to meet the requirements of the design, or of the conditions laid down for the working of the machine. The remainder are derived from members of either or both of these groups.

The essential part of a dynamo is the region occupied by the armature conductors in the magnetic field. This region may be named the "active belt" of the armature. An examination of the machine in terms of the energy generated in this active belt leads to the interesting result that machines of very widely varying size, output, and speed give a remarkably constant value in watts generated per cubic centimetre of active belt at unit velocity in unit field. This constant is represented by the symbol K.

A careful examination of a large variety of types and sizes of machines indicates that the value of this constant, K, may be taken as showing what may be counted upon as a safe load, having regard to the heating conditions. This value the author believes to be about $\frac{5}{10^7}$, or 5 ergs per second per cubic centimetre at unit velocity in unit field.

It is proposed to denominate the value, K, the energy factor of the machine.

Further experience in the use of this constant may reveal the relation between its value and the capital cost of the machine per unit of power generated. At present, it would appear as though a considerable variation in the energy factor may be permitted without materially affecting the cost per unit of power generated, and the electrical losses on many machines bear so small a ratio to the total losses, that the free use of ventilation may entirely obscure any disadvantage arising from an increase in the value of the energy factor. At the same time it would appear that, based as it is upon absolute units, it would form a sure standing ground for comparison of the actual performances of machines. The rise in temperature may be so variously estimated, and so materially modified by ventilation or otherwise, that the indefinite method of comparison on that basis ought to give way to something more sure.

A temperature test, based upon electrical measurements, an electrical and a commercial efficiency test associated with the energy factor and the cost price, would give for the dynamo a more complete basis of scientific and commercial comparison than is now available for any kind of machine.

The important bearing of the commutating conditions on the satisfactory working of the machine is, of course, thoroughly recognised by all designers.

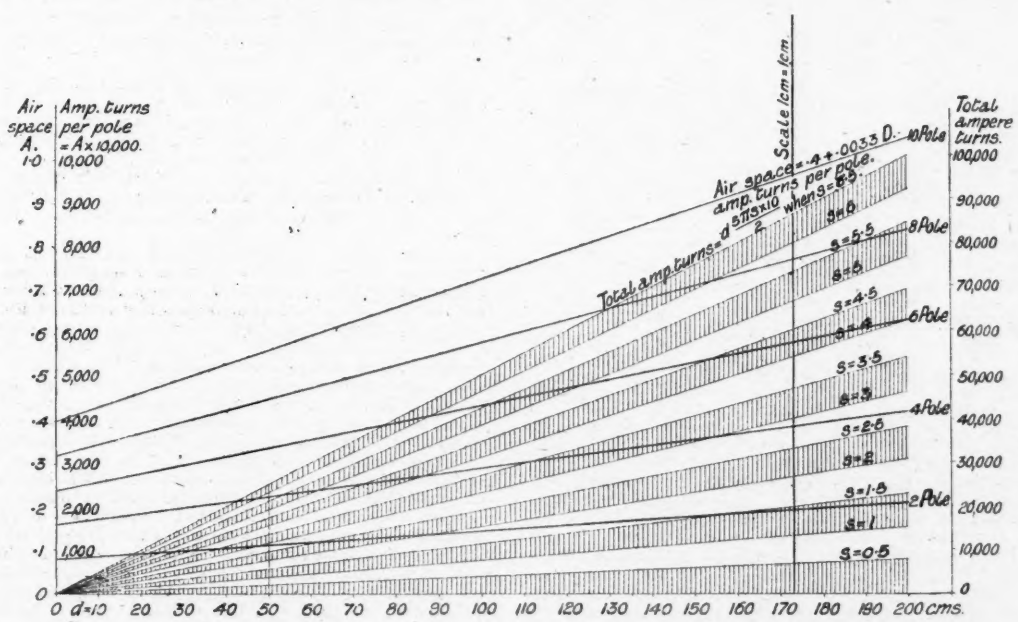


Fig. 2.

The most recent summary of this branch of the subject, so far as the author is aware, is contained in Messrs. Parshall and Hobart's book on "Electric Generators," in which a summary of the theoretical and experimental investigations into armature reaction is given, and the relation between the field turns and armature turns is fully discussed, as well as the relation between the reactance voltage

and electromotive force generated per section in the armature. It is the purpose of this paper to embody, in a simple form, the calculations necessary for determining the conditions which are there accepted as necessary for satisfactory working.

A formula is given which enables us readily to ascertain the value of the electromotive force of self-induction which has to be overcome in commutation. The electromotive force available for overcoming it depends, of course, upon the armature reaction, but for this part of the argument it may be assumed that this electromotive force is made equal to the average electromotive force generated in the conductors of the armature by their motion through the field.

As we are dealing with the reactance voltage in one section of the armature, we have to deal with the average electromotive force of the same region.

A section of the armature being defined as the path of the current from commutator to commutator, a formula is given for the average electromotive force generated in a section of the armature.

It is assumed that the ratio between the two electromotive forces has a very important bearing upon the commutating conditions of the machine. Doubtless the contact resistance of the brushes and their connections and the connections to the commutator have an important effect upon the value of the reactance voltage, but it is assumed that the values arrived at by the method referred to may with advantage be used in the design of machines. The use of the energy factor considerably simplifies the consideration of the question from this point of view, and makes it easy to plot curves of values of the ratio $\frac{e}{r}$ which will embody the necessary considerations.

A diagram, fig. 1, is given in which the ratios $\frac{e}{r}$ are plotted as ordinates, and the three values—(*a*) the ampere-turns of the armature; (*b*) the depth of the slot; and (*c*) the ratio between the size and speed of the machine and its output, are plotted as abscissæ. They are all interdependent, and the designer can compare his values directly by means of the diagram.

The value chosen for $\frac{e}{r}$ admits of a considerable variation, but there does not appear to be any material advantage to be gained in commutation from increasing its value above 2; and although many machines have been made with as low a value as 1·6, anything below this value appears to be dangerous.

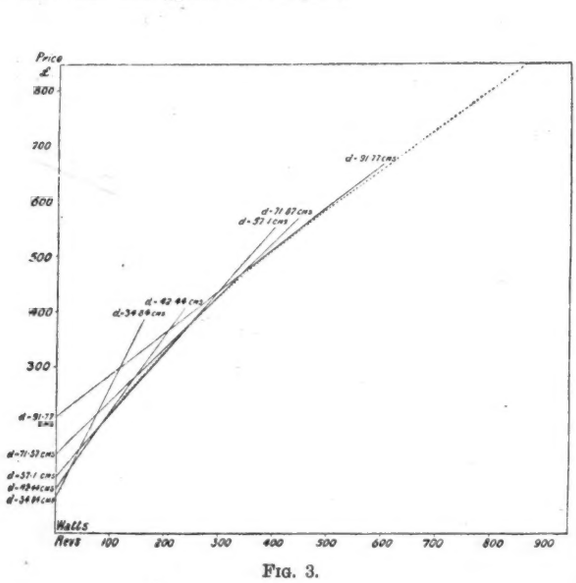


Fig. 3.

It has been assumed that the value of the electromotive force available for overcoming the reactance voltage can be taken as a definite proportion of the total electromotive force generated by the armature. This assumes suitable conditions of armature reaction, and it is necessary to make some provision for the accuracy of this assumption. This is done by fixing the number of poles so that the armature reaction bears a suitable relation to the magnetising force of the magnets, such that the ampere-turns on the armature per pole should not exceed 10,000 per centimetre length of the air space. A diagrammatic method of dealing with this part of the problem is indicated on fig. 2, in which are plotted values of "*d*" as abscissæ, and as ordinates the value of total ampere-turns, ampere-turns per pole and length of air space, the length of the air space being assumed a function of the diameter.

Taking the values of ampere-turns per centimetre of diameter and depth of slot from diagram 1, and having fixed the diameter of the machine, the ampere-turns per pole and the number of poles are readily found.

It will be seen that the relation of diameter and length depends not only upon the reactance voltage, but on the number of turns per section and the number of paths through the armature. It will, therefore, probably be found convenient in designing machines on the lines indicated, to start operations from the value of the number of armature turns per commutator section, fixing standard sizes of conductors and the current density to be used in them.

$\frac{m\,c}{p}$ is the value of the ampere-turns per section in the armature, and the required current output will give immediately the ratio $\frac{G\,m}{d\,p}$, raising the question of diameter and commutator segments independently of the speed at which the machine is run.

If the designer proceeds on an assumed peripheral speed, then the diameter is fixed at once, and the other quantities fall into line.

Turning to the consideration of cost, it is found that in the case of many groups of machines there is no regular ratio between the cost and output of the machines, and estimates are difficult to make.

There ought to be such a regular relation, and the following method is suggested for obtaining this result:—

Plotting watts per revolution as abscissæ and costs as ordinates, the position of each machine is marked, and points representing cost and output for each carcase of a given diameter with varying length are joined by a straight line, which is produced to cut the zero ordinate. This point gives the limit of cost to which this carcase approaches as the core length is reduced to zero, and may be called the base cost of any given carcase; the slope of the line drawn through the costs of the machine at different length shows the cost per inch length of "active belt" on that carcase. Increase in diameter increases the base cost and reduces the slope of the line passing through the costs of the actual machines, so that, starting from the smallest diameter and passing to the largest, will give a succession of straight lines, each touching its next lower neighbour at one point, and producing a curve made up of segments of the lines representing each machine, each segment showing the economical range of length for the machine which it represents.

This method will be found useful up to machines of about 100 centimetres diameter.

Beyond this size the cost is very approximately proportional to "$d^2\,l$," and is not within ordinary working limits seriously affected by the ratio $\frac{d^2}{l}$.

A diagram, fig. 3, is given as an illustration of the method suggested. The ratio between $d^2\,l$, the size of the machine, and $\frac{W}{R}$ watts per revolution, is readily ascertained from diagram 1 when a value has been chosen for $\frac{e}{r}$, and existing patterns or new designs can be brought into line in accordance with the costs as shown by the diagram.

TRIALS OF STEAM TURBINES FOR DRIVING DYNAMOS.

(Abstract of Paper read before Section III. by the Hon. Charles A. Parsons, F.R.S., and Mr. G. Gerald Stoney, of Newcastle-on-Tyne.)

A description of the earlier forms of steam turbines was given in a paper read before the Institution of Mechanical Engineers in 1888; since that date considerable improvements have been made in their design and construction, which have led to a general diminution in steam consumption, and, in the case of large condensing turbines, to some very remarkable results in steam economy. It is hoped that a short description of the turbines, and of the results obtained, may be not without interest at the present time.

Prior to 1890 all steam turbines had been of the non-condensing type, and of comparatively small size, and the results then obtained had not reached that degree of economy which was believed to be possible with steam turbines under practical working conditions.

The next step in advance was the construction of an experimental steam turbine of 200 h.p. in 1892. It was coupled to a 100-kw. alternator, and supplied with moderately superheated steam at 100 lbs. pressure per square inch. When tested by Prof. J. A. Ewing, F.R.S., it was found to consume 27 lbs. steam per kilowatt-hour, thus rivalling the performances of the best compound condensing reciprocating engines. This result placed the steam turbine amongst the most economical means of obtaining electrical energy from steam, and led to its adoption in the lighting stations of Newcastle, Scarborough, Cambridge, and other places.

About two years later considerable alterations of design and workmanship were introduced, a single-flow type of parallel-flow turbine being adopted instead of the original double-flow with right and left-handed turbines on each side of the steam inlet, the second set of turbines being replaced by rotating steam balance pistons, and the steam passing in one direction parallel to the shaft. This alteration materially improved the economy and reduced the amount of skilled labour required. The form and construction of the vanes or blades was perfected and strengthened, and many minor improvements conducive to economy were made, so that, even in the smaller sizes, a fair degree of efficiency has been obtained, as is instanced by the result of 28·8 lbs. of steam per kilowatt-hour, or about 17 lbs. per I.H.P.-hour for a 24-kw. steam turbine plant without superheat.

A 50-kw. steam turbine alternator for the Corporation of Blackpool showed a consumption of 28 lbs. per kilowatt-hour at full load without superheat, with a vacuum of 28 in.

Two 100-KW. turbo-dynamos for traction purposes at Blackpool gave a consumption of 26·4 lbs. per kilowatt-hour without superheat, and two others of the same size, constructed for the West Bromwich electric light station, gave a consumption on official trial of 24½ lbs. per kilowatt-hour with the moderate superheat of 60° F.

Two 200-KW. continuous current turbo-dynamos for the Blackpool Corporation tramways showed a consumption of steam of only 22 lbs. per KW.-hour, the superheat in this case also being 60° F.

An instructive series of tests has been made on various 500-KW. turbo-alternators. These are summarised in the following table:—

Various 500-kw. Turbo-Alternators.

Pressure of steam above atmosphere at stop valve.	Superheat at stop valve.	Vacuum in the turbine cylinder. Bar. = 30″.	Revs. per minute.	Load.	Steam used.	
Scarborough Electrical Supply Company.						
Lbs. per sq. in.	F.°	Inches of mercury.		KW.	Lbs. per KW-hour	Lbs. per hour
126	0	26·75	2,400	529	22·7	12,023
128	0	27·7	,,	258	26·4	6,812
164	0	28·1	2,600	0	—	1,477
Cheltenham Corporation.						
130	0	26·7	3,000	553	21·7	12,000
130	0	26·6	,,	278	26·2	7,280
133	0	24·0	,,	553	23·6	13,060
135	0	,,	,,	276	29·65	8,175
Blackpool Corporation.						
146	70	27·1	2,500	515	21·35	11,000
150	0	27·0	,,	502	23·1	11,600
152	0	29·0	,,	0	—	1,500
160	0	23·6	,,	0	—	2,530

It will be noted that the improvement in steam consumption resulting from a superheat of 50° F. is about 8 per cent., and from 100° F. it averages about 12 per cent.; also that for every 1 in. of vacuum above 25 in. or 26 in., the consumption falls about 4 per cent.

On this basis the steam consumption with about 140 lbs. steam pressure at the stop valve and no superheat under various conditions of load and vacuum has been prepared for a 500-KW. plant.

Consumption of 500-kw. Turbo-Alternators running at 2,500 revolutions with 140 lbs. steam pressure at the stop valve and no superheat.

Vacuum constant from full load to no load.	Consumption per KW.-hour.			
Inches of mercury.	Full load.	½	¼	No load. Lbs. per hour.
28	22·2	25·6	32·4	1,700
26	24·0	28·2	36·6	2,100
24	26·2	31·2	41·2	2,500
22	28·9	34·7	46·3	2,900
Vacuum rising from full load to no load.	**Consumption per KW.-hour.**			
Inches of mercury.	**Full load.**	**½**	**¼**	**No load. Lbs. per hour.**
From 28 to 29½	22·2	25·0	30·5	1,400
,, 26 to 28½	24·0	27·2	33·6	1,600
,, 24 to 27½	26·2	28·9	37·0	1,800
,, 22 to 26½	28·9	33·0	41·2	2,000

Barometer = 30″ mercury.

It will be observed that in steam turbines the steam consumption closely follows a right line law, or is proportional to the load *plus* a constant quantity which represents the consumption of steam at no load.

In connection with superheated steam, it may be mentioned that, as there is no internal lubrication of the turbines, none of the usual difficulties which occur with reciprocating engines are met with in its employment. Also the absence of internal lubrication renders the exhaust steam absolutely free from oil, so that the water from the hot well can be returned to the boilers direct without oil filters.

Special tests* have been made from time to time on turbine engines to verify the statement that no increase in steam consumption occurs with the age of the plant under fair wear and tear.

A long and exhaustive series of tests was made in January, 1900, by Mr. W. H. Lindley and Profs. Schroeter and Weber, on behalf of the city of Elberfeld, in Germany, on one of two 1,000-KW. turbo-alternators built at Heaton Works for that city. The turbo-alternators were constructed to give 1,250 KW. at 4,000 volts 50 cycles per second, the alternators being four-pole, running at 1,500 revolutions per minute, and directly coupled to the turbines. The expansion of the steam was carried out in two cylinders, a high pressure and a low pressure, the steam being expanded down to a little below the atmosphere in the first, and from that to the vacuum of the condenser in the second.

* Such as that made at the Cambridge electrical supply station on a 500-KW. turbo-alternator by Prof. Ewing.

Results of the Tests showing how the Steam Consumption depends on the Output of the Turbo-Alternator.

Amount of load.	Exact value of output. Kw.	Steam consumption per KW.-hour. Lb.	Steam consumption in one hour.
			Kg.
Preliminary trial	1,172·7	18·22	9,689
Overload	1,190·1	19·43	10,485
Normal load	994·8	20·15	9,092
Three-quarter load	745·3	22·31	7,542
Half load	498·7	25·20	5,695
Quarter load	246·5	33·76	3,774
No load with alternator excited	0	—	1,844
No load without excitation ...	0	—	1,183

A direct comparison of these results is not possible, because the measurements have not been made at one and the same steam pressure, and, above all, not with exactly the same amount of superheating.

Therefore, on the basis of the results of the measurements, the steam consumption has been calculated at the average superheating recorded in the observations, viz., 14·3° C., corresponding to a steam temperature of 197·3° C. These corrected results will be found in column (6) of the following Table.

Further, to enable a comparison to be made with the steam consumption of reciprocating engines, working with saturated steam, the equivalent steam consumption, calculated as saturated steam at 11 atmospheres, is given in column (7) of the same Table.

Based on Results of Tests.

Load in KW.	Average observed steam pressure in kgs. per cm². absolute.	Superheating.	Observed steam consumption per KW.-hour.	Measured consumption of heat per KW.-hour.	Corresponding consumption of steam at 11 kgs. absolute and at 14·3° superheating (1 kg. of steam = 669·2 cal.).	Corresponding consumption of saturated steam at 11 atmos. absolute (1 kg. of steam = 663·3 cal.).
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Kw.	Kgs. per cm².	C.°	Kgs.	Calories.	Kgs.	Kgs.
1,190·1	10·11	10·2	8·81	5,867	8·76	8·86
994·8	10·47	11·1	9·14	6,096	9·11	9·20
745·3	10·76	8·0	10·12	6,738	10·07	10·17
498·7	10·40	29·1	11·42	7,715	11·53	11·66
246·5	10·14	17·0	15·31	10,248	15·31	15·47
No load with excitation.	10·34	13·3	per hour. 1,844	per hour. 1,231,423	per hour. 1,840	per hour. 1,859
No load without excitation.	10·49	13·5	1,183	790,481	1,181	1,194

For the following outputs in round numbers, the steam consumption per hour is as shown:—

Output.	Steam consumption per hour.	Steam consumption per KW.-hour.
Kw.	Kgs.	Kgs.
1,250	10,786	8·63
1,000	9,189	9·19
750	7,496	9·99
500	5,707	11·41
250	3,821	15·28

On the second plant, tests were made to determine the advantages of superheating, and also the effect of varying the vacuum.

These show a gain of about 12 per cent. with 55° C. superheat, and that every inch of vacuum improves the consumption about 4 per cent.

In non-condensing plants, also, many tests have been made, but, as will be expected, the steam turbine compares rather more favourably with the reciprocating engine in condensing types. In a 100-KW. size a consumption of 39 lbs. per KW.-hour has been attained, and in a 250-KW. turbo-dynamo 38 lbs. per KW.-hour, both with about 130 lbs. steam pressure and no superheat.

In large sizes of 1,500 KW., with 200 lbs. steam pressure and 150° F. superheat, a consumption of 28½ lbs. per KW.-hour non-condensing has been guaranteed, and is expected to be easily attained, if not surpassed.

DISCUSSION.

Prof. SCHROETER was astonished at the excellent economy in steam consumption of the turbines tested by him at Messrs. Parsons' works. He had compared the efficiencies of a 1,500-KW. Parsons turbine and a Sulzer engine working in the same station at Elberfeld and the results were in favour of the turbine.

The Chairman (Mr. W. H. Maw) asked Prof. Schroeter for information concerning the parallel running of alternators which were driven by turbines and by piston engines.

Prof. Schroeter said that the parallel running had been satisfactory from the first, and had given no trouble.

Prof. Ripper suggested that high degrees of superheat (300° to 350°) of steam should be tried for turbines, as had been done in the case of piston engines. He thought it a very significant fact that the terminal pressure in a turbine is always the same as that of the condenser, and thought that a turbine used between the exhaust and the condenser of a piston engine would somewhat increase the economy of working. He said that the difficulty of applying superheated steam to a cylinder was the fear of causing unequal expansions and contractions in it owing to the changes of temperature on admitting and exhausting; moreover, the superheated steam was not admitted all round the cylinder, but on one side only, thereby causing bad strains in the material of which the cylinder is made. In a turbine, however, the temperature of each part of the outer cover is constant, though not uniform throughout the whole of the metal.

Mr. Bryan Donkin asked Prof. Schroeter for the figures showing results of the comparative trials of the steam engines and turbines at Elberfeld, and

Prof. Schroeter promised to have them sent in time for the printed report.

Mr. Stoney, in reply, said that he had made no experiments on very highly superheated steam applied to turbines, but had tried 30° of superheat, and found an increased efficiency of 6 to 8 per cent. He said that a Sulzer engine having a cyclic variation of 1 per cent. driving an alternator with 64 poles paralleled well with another alternator driven by a turbine with no cyclic variation. With a turbine a good vacuum in the condenser is very important, as the steam is very completely expanded. He saw no reason for not using highly superheated steam in a turbine, as there would be no trouble with the lubricating oil carbonising, as is the case with the cylinder oil of piston engines.

DESTRUCTION OF GAS PIPES BY MEANS OF ELECTRICITY.

(Paper read before Section VIII. by Dr. W. Leybold, of Hamburg.)

As is well known, for the distribution of gas in towns it is usual to lay long lengths of iron pipes, the larger of cast and the smaller of wrought-iron. The durability of these pipes varies from 25 to 50 years; those of cast-iron lasting longer than those of wrought. In a few cases, a quicker destruction takes place; for instance, when the pipes are embedded in cinders or ashes. Pipes are also soon corroded in gasworks, where they are frequently laid in spent gas lime or spent oxide of iron; the constant formation of sulphate of iron as well as sulphuric acid most certainly producing a dissolving effect. Formerly it was customary in small gasworks to allow the gas liquor to run into the ground, and this also caused corrosion. The pipes were formerly, and are now, principally coated with hot tar before being laid in the ground. Lately, several works, including those at Hamburg, have commenced to cover all wrought-iron pipes with canvas and boiled tar, in order to protect them from outside destructive influences.

In recent years a new, and previously unthought of, enemy of our gas pipes has shown itself—viz., electrolysis. Electric tramlines have been constructed, and through these a strong electric current is carried both above and below the surface of the ground. In most cases, at least so far as Germany is concerned, the construction of these tramlines is so arranged that an electric current from one or more stations of about 500 volts passes into the wires lying above the surface leading to the trams, and after running into the motor lying below the trams, returns, by means of the rails, to the engines at the electricity works. In order to cause the easier return transmission, the single rails are jointed at the points they meet by thick copper wires soldered to them. As the rails give a certain resistance to the current used, it is evident that part of the current on a favourable opportunity—*i.e.*, at a short distance—will pass through the earth into the gas and water pipes.

This happens in such a way that the current from the places far distant from the electricity works goes from the rails into the pipes; whereas near the same works the current which has gone into the earth returns to the rails, and the part remaining in the rails returns to the engines, giving the current by the return transmission wire. As the pipes yield a less resistance to the current than the earth, a larger proportion of the current passes through the pipes than into the earth itself. The current flows from the rails into the pipes in the districts further away from the electricity works, and in the vicinity of the works again flows from the pipes into the rails; the pipes in this case proving to be the positive pole. The difference of tension between the pipe and the rail in various districts can be easily ascertained. It was advisable to determine whether, in pipes in the vicinity of which there were no electric trams, an electric current was in existence.

Dr. Bunte sent his assistant, Herr Lubberger, to investigate such a water pipe on the tableland Plinz, near Karlsruhe. This tableland lies 140 metres higher than Karlsruhe, and is 6 kilometres distant from the nearest electric station at Durlach. The system of water pipes is certainly not influenced from the outside; and yet considerable tensions were found. Also, during the time when the electric trams were not running at night at Karlsruhe, tension was observed in the gas pipes. Electric current flows in the pipes, and that pretty constantly.

The existence of the current at points which could not possibly be influenced by the electric current, can only be traced to the fact that the pipes are made of cast and wrought-iron, and that lead is used as a jointing material, which metals, lying under damp ground, produce a galvanic action. When early in the morning the traffic of the trams commences at Karlsruhe on one line only, it affects the tensions through the whole length of pipes to the most distant parts. When the tramline is in full working, there is everywhere a tension difference. In Hamburg this amounts to scarcely anything in some places, but generally about 0·2 to 1 volt, and near the electricity works even as much as 4·65 volts. It must be borne in mind that at that time the Hamburg trams were only supplied from one electric works in the Carolinen Street, so that the current in the rails must always return there. It may be seen from the yearly report for 1900 that the electric working line was about 100 km. long, and that about 400 cars were in use. The annual consumption of current amounted to 13 million kilowatt-hours.

The gasworks own a line of main pipes 526 km. in length and 50 to 1,100 mm. in diameter, with 443 km. of service pipes for houses. The experiments were extended over the whole town; and, as already stated, some tension was found at almost every point.

Now it is known that by the electric current, in the presence of saline solutions of different kinds, metals can easily be dissolved. Chloride of sodium is completely split up; and this is easily seen when two iron plates are placed in a solution of chloride of sodium and a current allowed to pass through them. In the negative pole a development of hydrogen at once takes place, while the fluid rapidly becomes thick through the separation of green protoxide of iron. Chloride of sodium is split up by the electric current into chlorine and sodium, which latter forms with water sodium hydroxide and hydrogen. The chlorine runs to the positive pole and forms there protochloride of iron. This is precipitated by the sodium hydroxide as mentioned as protoxide of iron. The process thus goes on until the positive pole is completely dissolved.

The process is easily shown if a current of electricity is passed through a thick glass pipe, closed at both ends by sheet-iron plates and filled with sand soaked in a solution of chloride of sodium. The sand at the positive pole becomes of a green colour as it sucks up the protoxide of iron which is formed. By degrees a yellow rust is produced through the admission of air. The same effect is caused by a solution of chloride of ammonia, gypsum, carbonate of lime, in such organic salts as are always found in the earth, and also of a watery solution of earth.

The ground in Hamburg contains small quantities of chloride of sodium to the extent of 0·006 to 0·04 per cent. It is also known that the electric tramway authorities in winter time melt up the snow and ice on the rails with raw salt or refuse of refined nitrate of soda. Soft ground is saturated with the solution, whereas from asphalt or granite pavement it flows off to the sewers. Accordingly an opportunity is afforded for the eating up of iron in the earth in the presence of a solution of salt and an electric current. American newspapers have from time to time mentioned this matter, but in Germany nothing of the kind was noticed until a few years ago. In Hamburg the first electric tramway (called the circular tram) was constructed in 1894, and gradually all the tramways were converted into electric trams, the whole work being completed by about the end of 1899.

In April, 1899, close to the electricity works in the Carolinen Street, an escape of gas was found. On one side of the street is the main gas pipe of cast-iron. Wrought-iron service pipes cross the road to the lamps on the other side. In the middle of the road there are two lines of tramway rails, cars passing at intervals of 3 minutes, so that about every 1½ minutes a tram passes any particular spot. The rails are placed upon a bed of concrete 0·2 metre thick. The gas pipes are laid at right angles to the rails at a depth of from 0·55 to 1 m. The street is paved with granite setts jointed with asphalt. Upon investigating the cause of the gas escape a hole was found in a wrought-iron pipe under the first rail; and after further investigating the matter a complete penetration was discovered under every rail. The pipe was taken out of the ground, and the four holes coincided exactly with the positions of the rails. Upon closer examination it was found that nearly all the pipes in this street were damaged in a similar way.

Owing to the holes fitting in exactly with the positions of the rails it was clear that an electric influence was the cause. A melting of the pipes, as was often found in the case of the transmission of a strong current into gas pipes in houses, had evidently not taken place.

The 1-in. pipes are covered with canvas soaked in boiled tar. The investigation in the laboratory gave the following result:—In some places the tar as well as the canvas had fallen off and the pipes were eaten through in parts to the size of a centimetre. In removing the covering it was found that the corrosion existed in every stage from the beginning until the complete penetration. Curiously enough the destruction was principally of spiral formation, and coincided with the wrapping of the canvas where between the strips of the canvas a portion of the tar had been pressed out.

In many places there were blisters between the iron and the tar, which were filled up with a green solution of protochloride of iron; in some places also with crystals of the same salt. From such a blister 0·032 grain of crystallised protochloride of iron was taken out; the fluid (about 1 cubic centimetre) contained 0·0604 grain of protochloride of iron, 0·0086 grain of chloride of sodium, 0·0095 grain of chloride of ammonia, and 0·0037 grain of free hydrochloric acid. The solution was very sour, and a strong destruction of the iron was visible.

At other places there were also found blisters concealed by the layers of tar, which were filled with a green, slimy mass of protoxide of iron, of which it contained about 0·2 grain. Here also the decay was strongly visible. In other parts the iron was com-

pletely eaten through, and covered with a thick layer of rust; the tar, as well as the canvas at these places, having become soft and brittle. The rust of the iron was very considerable, and contained acid, besides oxide of iron, about 9½ per cent. protochloride of iron, and chloride of iron; also 0·8 per cent. of sulphate of iron. Only 0·12 per cent. of chloride of sodium was found.

The collection of these chlorides of salts in one place is very strange. They were derived without doubt from common salt. Therefore, where a particle of a solution of salt can penetrate the tar covering the iron, the destruction commences, and, as previously stated, in one of two ways, either into protochloride of iron or protoxide of iron—apparently as the formed hydrate of sodium gets to spot in question, and replaces the dissolved iron, or not.

Examined samples of the earth taken from the vicinity of the pipes consisted of clayish sand containing 0·006 to 0·04 per cent. of chloride of sodium, and in other parts 0·007 and 0·012 per cent. Apparently the wrapping with boiled tar and canvas favours the destruction, for in the blisters under the tar it quietly goes on, while with a direct bedding of the pipes into the earth without any covering, the earth would have absorbed the fluid.

All the gas pipes in the Carolinen Street were taken up and replaced by others all covered; but after the expiration of seven to eight months, the destruction showed itself to have taken place again in the same manner as before—the pipes being penetrated with holes.

New trials were then made with pipes simply covered and tarred, also with untarred pipes, and others protected by being placed inside a second one. After two years—during which time the electricity works had taken some measures to prevent damage—the covered pipes showed signs of destruction, also the outer pipe, while the one inside it remained intact. The plain tarred, and also the untarred pipes, were fairly well preserved, though heavily covered with rust; but it could not be decided whether to a greater extent than in other streets. In exposing them to the air, the rust covering of about 2 mm. fell off. Besides this, the pipes were covered all round with a firm layer of sand.

The quantity of common salt and soluble salts of iron in the rust was in this case very small. One pipe covered partly with 5 mm. of copper wire was laid down. The same, after two years, had turned into a green mass, consisting of carbonate of copper and hydrate of copper, besides chloride of copper, and 0·7 per cent. of chloride of sodium. It appears doubtful whether the packing protects the pipes; but anyhow, at every bending of the covered pipes, the covering was destroyed by the falling off of the tar. Meanwhile other pipes of different kinds, covered and uncovered, were placed in particularly dangerous spots.

Every endeavour must be made to reduce the currents passing into the pipes, and when laying down electric tramways, great care must be taken to prevent the current flowing into the earth. This can be done in one way by the laying of well-conducting rails, the rails having sufficient transverse section, and the points of contact well joined together by soldered copper wire. The welding of the points of contact (according to the system of Dr. Goldschmidt, of Essen) by means of thermite will probably be of great service. A further method—and this should certainly be done in Hamburg—is by fixing insulated return transmission cables in many places, in order to direct the current back from the rails to the electricity works, and thus to disburden the rails. These cables should be distributed in such a manner that the tension in the rails becomes sufficiently small. Only where small tramways come into consideration can such cables be dispensed with.

With the quick development of the electric tram traffic in Hamburg, the engines were in the beginning connected with the rails in the vicinity of the works by plain copper wires, and it was remarked that, even under these wires, the gas pipes showed signs of decay. Formerly the current for the trams was supplied from one works only. During last year a second one was opened at Barmbeck, and shortly a third one at Hammerbrook will be opened, in order to assist the others. The supply will then be divided among the three works. The tension at each place will therefore be lessened.

The electricity authorities were persuaded to place a large number of insulated return transmissions similar to the feeding cables of the trams, and in consequence of this measure, the destruction of gas pipes caused by the current escaping from the rails can in future be left out of the question. While formerly in the Carolinen Street tensions between rails and gas pipes occurred up to 5 volts, these have now been lessened to 0·45 volt maximum. Also, in the whole system of the town, a pretty uniform and very small tension is observable, which, in some cases, is nought, and even has a tendency on the other side.

The whole affair has cost a great deal of money to the electricity works, but the measures taken proved to be necessary in order to avoid the threatened danger to all the gas and water pipes. It has to be remarked that in cast-iron pipes no such destruction has so far been perceptible—the pipes of the waterworks, which generally are lying deeper than those of the gasworks, showed no signs of decay, with the exception of some lead pipes in the vicinity of the rails.

Not long since, at Erfurt, similar damage appeared. Upon the commencement of the running of the electric trams, the old rails of the tramway were kept in use. They were not suitable, however, for the heavy electric tram; the consequence was that the connection of the rails became bad, owing to the proportionately heavy bending at the points where the rails meet each other. They gradually became looser and looser; and this, in conjunction with the very small transverse section, caused great electrical resistance to the current. This circumstance is no doubt the cause which led to the electrical destruction of the pipes at Erfurt.

Recently the German Electrical Technical Association has been busy with the drawing up of directions for the protection of gas and water pipes; and has prepared a statement of precautions, of which particulars will shortly be published. In the report, the requisite directions will be given for construction and arrangements, so that the escaping currents may be reduced to a minimum. At any rate, gas and water works can demand that the electricity authorities shall do everything in their power to protect their pipes. It may be remarked that electric currents in dwelling houses are suspected of having caused destruction to imbedded pipes within the walls, whereby the electric wires must have a connection with the earth. Such an example has been recently found.

It is well known that among different metals currents circulate in a solution of salt, as, for example, in a gasmeter, the drum of which consists of Britannia metal, and the outer casing of lead-covered iron plate; whereas the filling is chiefly salty glycerine, chloride of lime, chloride of magnesia, or water. The water of Hamburg is filtered water from the River Elbe; one litre containing 0·25 grain of salt. Even this is sufficient to produce a current. This may be to a certain extent the cause of the gas-meter drums being destroyed. A slight current also circulates in the station governor of a gasworks between the outside tank and the governor bell; the tank consisting of cast-iron, and the bell commonly of tin-plated iron sheets. Sometimes in this apparatus signs of destruction are found, principally on the bell and on the closed air vessel.

It is hoped that the author has shown in the paper that the electric currents are of great importance to gas companies, and that they are worth serious observation, with a view to the protection of their property.

THE ECONOMY OF ELECTRICITY AS A MOTIVE POWER ON RAILWAYS.

(Abstract of Paper read before Section I., Tuesday, September 3rd, 1901, by Prof. C. A. Carus-Wilson, M.A., Assoc.M.Inst.C.E.)

This paper deals briefly with the economic considerations which will probably govern the substitution of electricity for steam as a motive power on railways.

It is generally acknowledged that the branch lines are the least profitable part of a railway system, and that in many cases the receipts per mile are barely sufficient to pay expenses. There is also evidence that in the near future the unremunerative character of the branch lines will become still more marked, since the traffic they at present carry is being seriously menaced by the network of electric tramlines that is spreading in all directions throughout the country.

To pay expenses with steam traction it is necessary to make up trains of considerable length, so that where the traffic is small, as on branch lines, the interval between the trains is large. This results in a poor service between towns and districts connected only by branch lines, and gives rise to considerable difficulty and delay in making connections at main line stations.

If the train service on the branch lines could be broken up into smaller units moving more frequently, cross-country travel would be greatly facilitated and the punctuality improved.

The cost of working the line under the existing conditions with steam must be divided into two parts, and the running expenses per train-mile, which vary with the number of trains run, must be distinguished from the fixed expenses which do not so vary.

The fixed expenses per train-mile multiplied by the number of trains per day on any given line under the existing conditions, gives the contribution of that line per day-mile to the general fund for purposes of maintenance, &c. This will then constitute a fixed sum per day-mile to be provided for under the new conditions, together with the increased running expenses. The traffic per day-mile must exceed this amount, plus a sum required to pay the interest on the electric installation, before the line can be said to pay.

The working expenses of the principal English railways, taken from the Board of Trade Returns for the year 1900, are given in Table I.

Table I.

Working expenses and proportion of goods and passenger traffic for the principal English railways for the year 1900.

	A	B	C	D	E	F
	Train-miles.		Goods.	Expenses per train-mile.		
	Goods.	Passenger.	Tons per train mile.	Fixed.	Running.	Total.
	%	%		d.	d.	d.
London and North-Western	46	54	1·97	31·4	11·1	42·5
Great Western ...	50	50	1·62	25·1	11·0	36·1
Great Northern ...	50	50	1·45	22·9	11·4	34·3
Great Eastern... ...	41	59	1·31	28·0	10·3	38·3
Midland	60	40	1·43	22·6	11·6	34·2
London and South-Western	27	73	1·34	31·6	10·6	42·2
Lancashire and Yorkshire...	35	65	3·33	30·1	11·5	41·6
South-Eastern and Chatham	22	78	2·00	34·4	13·0	47·4
London, Brighton and South Coast... ...	19	81	2·10	32·5	12·8	45·3
Cheshire Lines ...	44	56	2·80	28·8	13·9	42·7

In column D are given the fixed expenses, including maintenance of way, &c., repairs and renewals of carriages, traffic expenses, rates and taxes, miscellaneous and legal. In column E are given the running expenses, including wages, coal, water, and locomotive repairs. Column C gives the goods tons carried per goods train-mile.

Columns B and D show how the fixed expenses increase with the passenger traffic. Thus with the Midland, where the passenger train-mileage is 40 per cent. of the whole, the fixed expenses are only 22·6d. per train-mile, while on the southern lines, where the passenger traffic is about 80 per cent. of the whole, the fixed expenses amount to as much as 32 to 34d. per train-mile. An increase in the passenger traffic need not, however, be accompanied by a rise in the fixed expenses; for if the traffic were evenly distributed over the working day, a considerable increase could be dealt with by the existing staff. For this reason the amount of the fixed expenses assumed in the following comparison will be taken for a line with an average amount of passenger traffic, as, for instance, the Great Northern, where the fixed expenses are 22·9d.

The figures in column C, taken in conjunction with column A, give some idea of the relative weights of the goods trains hauled on the different lines. Comparing these columns with column E, it will be seen that in spite of the variation in the weights hauled, and in the proportion of goods and passenger traffic, the item for running expenses is very nearly the same on the first seven lines.

Taking the Great Northern again as a representative line, the running expenses may be sub-divided as shown in Table II. The coal item is, of course, abnormally large, the average price of coal during 1900 having been about 10s. 9d. Reducing this figure to the equivalent for coal at 8s. a ton, we get 3·36, bringing the cost per train-mile down to 10·33d.

Table II.

Running expenses of the Great Northern Railway for the last half-year of 1900.

Wages	3·81d.	per train-mile.
Coal	4·50d.	„ „
Water, oil, &c. ...	0·77d.	„ „
Repairs, wages ...	1·34d.	„ „
„ materials	1·05d.	„ „
Total ...	11·47d.	„ „

The wages of the guard of the train should be included in the above figure in order that it may represent the whole of the expenses which vary with the number of trains run. Taking the wages of a driver at 42s. per week, of a fireman at 22s., and of a guard at 25s., the item "wages," under running expenses, should be increased by 1·52d. This amount must be also deducted from the fixed expenses, giving us finally 21·38d. per train-mile as the expenses which do not, and 11·85d. as the expenses which do, vary with the number of trains run.

We can now take the case of a branch line with, say, six trains each way per day. The running expenses will be 12 × 11·85, or 142d., and the fixed expenses 12 × 21·38, or 256d. per day-mile. Hence, if the line is to pay expenses, the receipts per day-mile must amount to 398d., or the traffic, estimated in equivalent numbers of third-class passengers, must be 398 per day-mile.

Instead of a steam-driven train every two hours, we may have an electrically-driven train every half-hour, or 24 each way per day instead of six, each of the new trains having seating accommodation equal to one-fourth of one of the original trains. The new trains may consist of motor-cars and ordinary carriages trailing. By getting rid of the locomotive, about 20 per cent. of dead weight is saved, and since the weight of the carriages will be one-fourth of that in the original train, the new trains will weigh one-fifth of the old trains. This will reduce the coal item in the running expenses to 0·68d. per train-mile, and that for water, oil, &c., to 0·15d., as shown in Table III.

Table III.

Running expenses in pence per train-mile.

	Steam.	Electricity.	Liverpool Overhead Railway.
	d.	d.	d.
Coal	3·36	0·68	0·55
Wages of driver and assistant	3·81	1·24	1·15
„ conductor	1·52	1 01	1·01
„ at generating station	—	0·62	0·69
Water, oil, &c....	0·77	0·15	0·42
Repairs, wages	1·34	0·67	0·40
„ materials	1·05	0·52	0·65
Total	11·85	4·89	5 17

The coal consumed per ton-mile is here taken to be the same for an electric generating station driving electric motors on the cars as for steam locomotives.

On the City and South London Railway the cost of repairs is 0·92d. per train-mile, about 38 per cent. of that on the Great Northern. Taking 50 per cent. as a moderate estimate, we get 0·67d. per train-mile for wages, and 0·52d. for materials for repairs to electric motor cars and to the generating station.

The great simplicity of the electric equipment enables us to substitute for the highly-paid driver and his fireman one motor man, say, at 32s. a week, thereby halving the wages item on the locomotive. Further, as the electric motor is ready to start at any moment a great deal of time is saved during the week, and with the increased service a larger proportion of the actual working hours will be usefully employed. In consequence of this economy of time, the wages item is reduced to 2·25d. per train-mile. The wages of the men engaged in the generating station may be taken at 50 per cent. of the motorman's wages, making the wages per train mile altogether 2·87d. The total cost per train-mile for running expenses with the electric train is thus 4·89d., as compared with 11·85d. for the original steam train.

The running expenses on the Liverpool Overhead Railway for 1899 are given in Table III. About 180 trains are run each way per day, with a total of 403,000 train-miles in the year (1899); this large train mileage, of course, reduces the fixed expenses per train-mile to a low figure, but does not affect the running expenses.

With the new system the fixed expenses would be the same as before, while the running expenses would increase in proportion to the increase in the frequency of the service, that is, in the case assumed, fourfold. Hence the fixed expenses will be 256d. per day mile and the running expenses 48 × 4·89, or 240d., making a total of 496. So that in order to pay expenses the traffic would have to increase from 398 per day mile to 496, or 25 per cent. This increase, however, would not pay the interest on the capital required for the electrical equipment.

The cost of the electrical generating station, with distributing system and rolling stock for a half-hour's service of 40-ton trains, on a line not exceeding, say, 15 miles in length, would probably be about £8,000 per mile. At 3½ per cent. interest this would mean an additional 184d. per day mile, making the total increase of traffic required to pay all expenses and interest 70 per cent.

The increase of traffic resulting from a given increase in the frequency of the service depends upon local conditions, but if a fourfold increase in the number of trains per day were to double the traffic, the profits per day mile would be 10s. If the traffic were trebled the profits would be 43s. The average profits per day mile for the whole of the Great Northern Railway system are about 124s., so that the use of electricity on branch lines is certainly worth consideration as a means of making them yield a more substantial proportion of the total profits than they do at present.

ON THE RESISTANCE AND ELECTROMOTIVE FORCES OF THE ELECTRIC ARC.

By W. DUDDELL, Whitworth Scholar.

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(Abstract.)

The discrimination between resistances and electromotive forces in conductors or apparatus, in which both of these quantities are functions of the current, is considered, and it is pointed out that whether such an apparatus may be said to possess a resistance, or an E.M.F., or both, depends to a large extent on the nature of the definition of these quantities, and a definition of these quantities is adopted.

The essential stipulation is made that whatever means be used to measure the resistance and E.M.F.'s of the arc, the conditions of the arc must not be in any way changed by the test. It is considered that the main phenomena of the arc depend on the exact thermal conditions of its different parts, and on the distribution of the heated gaseous and other particles, so that it is necessary to maintain these constant during the test. This leads to the condition that not only must the testing current used be very small, but also that the test must be completed in an exceedingly short time after applying the same.

As illustrating how very short a time may be allowed to elapse, it was found that an appreciable change in the thermal conditions of an arc had taken place in 1/10,000 second after changing the arc current by as little as 3 per cent.

Historical.—A brief historical *résumé* is given showing that previous experimenters have not succeeded in measuring the true resistance and back E.M.F. of the arc, due to their not having realised the importance of completing the test before the conditions of the arc have had time to be altered by the testing current.

Those methods, similar to the Kohlrausch method of measuring the resistance of an electrolyte, in which an alternating testing current is superposed on the direct current, such as that employed by Messrs. Frith and Rodgers, who found that what they measured as the resistance of the arc had in some cases a negative value, are shown to have failed owing to the frequency of the alternating testing current not being high enough. This frequency should be, instead of a few hundred periods per second, as used by previous observers, many thousand periods per second, in order that the conditions of the arc may not vary, and the true resistance may be obtained.

Preliminary Experiments.—In the preliminary experiments the oscillatory discharge of a condenser was superposed on the main direct current through the arc, and was used as the testing current, the wave forms of the superposed oscillatory P.D. and current being recorded by means of an oscillograph. If the arc behaved as a non-inductive resistance, the waves of P.D. and current should be similar curves and in phase. This is found *not* to be the case

with frequencies up to 5,000 periods per second. The author concludes from these experiments that each increase made in the frequency of the superposed alternating testing current has led to the arc conditions being less affected by it, and in consequence, to the arc behaving more and more like an ordinary non-inductive resistance, and therefore that much higher frequencies are required to obtain the true resistance. In fact, frequencies up to 120,000 periods per second were finally used. Owing to experimental difficulties in employing the above method with much higher frequencies, a fresh method was adopted.

Basis of Method Adopted.—An apparatus A is considered which has resistance and E.M.F., but no self-induction or capacity, and through which a steady current is flowing. There is mixed with the steady current an alternating testing current. It is shown that, if the apparatus A possess a true resistance, and if the frequency of the testing current be such that *the conditions of the apparatus are not in any way changed by it*, then the resistance of A will be a constant over a range of variation of the current, and equal to the impedance of A to the superposed alternating current.

A criterion that the apparatus A has a constant resistance is that the power factor of A, with respect to the alternating testing current, must be unity. It is concluded that in order to prove that the arc has a true resistance, and to find its value, it is necessary to show:—First, that it is possible to find a value of the frequency of the testing current for which the power factor of the arc with respect to this current is unity; second, that the power factor remains unity, and the impedance constant, even when the frequency is greatly increased above this value; thirdly, to determine the value of the impedance of the arc under these conditions, which will be its true resistance.

Method of Measuring the Impedance and Power Factor.—Owing to the high frequency of the testing current finally used, viz., 120,000 periods per second, it was difficult to devise a satisfactory method of measuring the impedance and power factor; wattmeters and dynamometers could not be used, as at these high frequencies their windings behaved more like insulators than conductors, owing to their self-induction. The method finally adopted was the well-known three voltmeter method, for which three pieces of special apparatus were used—

(1) An alternator to produce the high frequency currents.

(2) A new measuring instrument called a "thermo-galvanometer" to measure the three voltages.

(3) A standard resistance with which the impedance of the arc was compared, which had a time constant of only $2{\cdot}7 \times 10^{-7}$ seconds.

The High Frequency Alternator.—The alternator is of the inductor type; it was belt-driven from two discs by means of a figure of 8 drive, each disc being separately belted to the source of power so as to balance, as far as possible, the pull on the alternator spindle due to the driving belt. The speed of the alternator was 35,400 revolutions per minute, and the highest frequency 120,000 periods per second. To give an idea how very high this frequency is, it is mentioned that if a frequency of 100 periods per second be represented by 10 in., a very ordinary scale in plotting curves, then the squared paper that would be required to plot the curve between impedance and frequency for the solid arc, which extends over the range from 250 to 120,000 periods per second, would be 1,000 ft., or about $\frac{1}{5}$th *mile* long.

It was found that the spindle alone of the alternator without the inductor could be driven at 60,000 revolutions per minute, or 1,000 revolutions per second.

A table of high frequency alternators shows that this alternator gives a frequency seven or eight times as high as the highest value previously attained.

The Thermo-Galvanometer.—The principle of this new instrument consists in causing the current to be measured to flow through a very fine wire, the heat radiated by the wire being measured by a modified Boys' radio-micrometer. The instrument is practically non-inductive, and may be used equally well for direct or alternating currents. The actual instrument used has a resistance of about 18 ohms, and gives a deflection of 500 scale divisions at a scale distance of 2,000 divisions (one scale division = $\frac{1}{10}$th in.) for a current of about 9×10^{-4} ampere.

Telephone and microphone currents can be easily measured with this instrument.

Results Obtained by Varying the Frequency.—This, the fundamental investigation of this communication, consists in varying the frequency of the superposed alternating testing current to see whether, at a sufficiently high frequency, the conditions of the arc remain constant. The criterion that the conditions of the arc remain unchanged has been shown to be that the power factor, as measured with the superposed alternating current, is unity. Under these circumstances the true resistance will be equal to the impedance. It is experimentally found by sufficiently increasing the frequency, that the power factor approximates asymptotically to + 1, and that for the highest frequencies used it is + 1 to within the limits of experimental error; therefore at these frequencies the variations of the P.D. and current obey Ohm's law, and the impedance of the arc is equal to its true resistance.

With *solid* carbons the power factor at 250 periods per second is − 0·91; on increasing the frequency it decreases numerically until it vanishes at 1,950 periods per second; with further increase of frequency the power factor increases rapidly at first, then more slowly becoming asymptotic to + 1, and finally practically attains this value at 90,000 periods per second; above this frequency the power factor is within the limits of experimental error + 1 up to the highest frequency used, viz., 120,000 periods per second. The impedance of the *solid* arc increases with increase of frequency from 0·97 ohm at 250 periods per second to 3·8 ohms at 90,000 periods per second, above which it remains practically constant.

The true resistance of the above arc 3 mm. long between 11 mm. solid "Conradty Noris" carbons, through which a current of 9·91 amperes is flowing, is found to be 3·81 ohms.

The P.D. accounted for by ohmic drop is therefore 37·8 volts out of an observed P.D. arc of 49·8 volts, so that *there appears to be a real back E.M.F. opposing the flow of the current, in this arc of 12 volts.*

With *cored* carbons the power factor at 250 periods per second is + 0·67, and it increases until it is practically + 1 at 15,000 periods per second, and remains unity within the limits of experimental error up to the highest frequency tried of 50,000 periods per second, the impedance becoming practically constant as with solid carbons. *The true resistance of the above arc 3 mm. long between 11 mm. cored "Conradty Noris" carbons, through which a current of 10 amperes is flowing, is found to be 2·54 ohms, and the back E.M.F. 16·9 volts.*

The fact that the solid arc has, at low frequencies, a negative power factor, indicates that the arc is supplying power to the alternator; this is shown to be the case by means of a wattmeter. This is not, of course, at variance with the principle of conservation of energy, as the alternating energy given out by the arc is derived from the direct current energy supplied to it. This fact that the solid arc is capable of transforming, under suitable conditions, direct current into alternating current is the basis of the "Musical Arc" recently shown for the first time, at the Institution of Electrical Engineers.

Effect of Varying the Direct Current.—Having found that it is possible to measure the true resistance and back E.M.F. of the arc, the effect of changing the direct current, the arc having a constant length of 3 mm., is examined.

The resistance of both the *solid* and the *cored* arcs is found to increase with decrease of the current through the arc, apparently tending to become infinite for current 0.

The back E.M.F. of the *solid* arc first decreases with increase of current and then increases again, having a minimum value of 11·3 volts at about 6 amperes. With *cored* carbons the back E.M.F. increases with increase of current from 12·2 volts at 1 ampere to 18·5 volts at 20·8 amperes. The high P.D.'s required to maintain small current arcs are shown to be due to the high resistance of these arcs.

The connection between the resistance r and the current A for the *cored* arc, length 3 mm., between 11 mm. "Conradty Noris" carbons, can be approximately expressed over the range 1·5 to 20 amperes by

$$(r + 0{\cdot}25)\,A = 29.$$

For the *solid* arc, length 3 mm. between the same size and make of carbons, and over the range 1·5 to 11 amperes, the relation is

$$r = \frac{33{\cdot}5}{A} + \frac{42}{A^2}.$$

Effect of Varying the Arc Length.—The direct current through the arc being kept constant, the change in resistance and back E.M.F. due to change of arc length is examined. It is found that both for *solid* and for *cored* arcs increasing the length increases the resistance, the curves between resistance and length being very similar to those between P.D. arc and length. This latter curve is generally assumed to be a straight line for *solid* arcs, but such was not the case over the wide range of length, 1 to 30 mm., used for these experiments.

Effect of Varying the Nature of the Electrodes.—Both the resistance and the back E.M.F. are found to depend greatly on the composition of the electrodes; thus simply soaking a pair of solid carbons in potassium carbonate reduced the resistance of the arc between them from 3·81 to 2·02 ohms, and increased its back E.M.F. from 12 volts to 15·6 volts, the arc length and direct current being kept constant: similar results were produced by introducing other impurities. The author is of opinion that the resistance of an arc between *perfectly pure carbon* electrodes would be very high, so high that it might be impossible to maintain a true arc, and that traces of impurities are essential to provide the carriers of the electric charges in the vapour column.

Seat of the back E.M.F.—In order to determine whether the back E.M.F. and resistance are localised at the electrodes or are distributed along the vapour column a search carbon was introduced into an arc 6 mm. long between *solid* "Conradty Noris" carbons, 11 mm. diameter, current 9·91 amperes. The impedance to the high frequency testing current of that part of the arc between the search carbon and each of the main carbons was measured for three different positions of the search carbon. From these tests it is deduced that the resistance of the above arc, as a whole, consists of three parts—a resistance at or near the contact of the positive electrode and the vapour column of about 1·61 ohms; the resistance of the vapour column, about 2·5 ohms; and a resistance at or near the contact between the vapour column and the negative electrode of about 1·18 ohms.

The back E.M.F. consists of two parts located at or near the contact between the electrodes and the vapour column. That at the *positive* electrode, about 17 volts, *opposes* the flow of the direct current, while that at the *negative* electrode, about 6 volts, *helps* the flow of the direct current, *i.e.*, is a *forward* E.M.F.

Conclusion.—The author considers that the new facts given in the paper assist in formulating a consistent explanation of the resistance and back E.M.F. of the arc. The values found for the resistance of the vapour column and for the contacts between it and the electrodes offer no serious difficulties. The greater part of the two E.M.F.'s are considered as being most probably due to thermo-electric forces, and experiments in support of this view are described, in which it was found possible to obtain a P.D. of 0·6 volts by unequally heating two *solid* carbon electrodes with a blow-pipe flame, the voltmeter indicating that the hotter carbon was

positive to the cooler. By using *cored* carbons and adding potassium salts, the P.D. was increased to 1·5 volts. It is pointed out that the differences of temperature existing in the arc must be many times as great as those which it is possible to produce with the blow-pipe, as the cooler electrode must be red hot, or else it does not seem to make contact with the surrounding flame.

On the Resistance of an Electrolyte.—In measuring the resistance of an electrolyte by the Kohlrausch method, it is often assumed that the errors due to polarisation are avoided if the frequency of the alternating or interrupted current used is as high as a few hundred periods per second. To investigate the accuracy of this assumption the arc was replaced by a cell containing sulphuric acid, density 1·20 (temperature 20° C.), as the electrolyte, and its impedance and power factor tested in exactly the same way as those of the arc. It was found with this cell that it was not until the frequency exceeded 10,000 periods per second that the electrolyte behaved as a non-inductive resistance, and the errors due to the polarisation were avoided. If the resistance of this cell were tested in the ordinary way at a frequency of 100 periods *per second*, the value obtained would be over *twice* its true resistance. It is concluded that unless other methods are adopted to eliminate the effects of polarisation, *it must not be assumed that the use of alternating currents of ordinary frequencies of a few hundred periods per second eliminates the possibility of errors due to polarisation.*

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

17,518. "Improvements in electric motors." J. P. JONES. September 2nd.

17,538. "An automatic two-instrument switch for electric purposes." R. T. GIBBS. September 2nd.

17,539. "An improved thermo-electric fire and temperature alarm." M. H. HUMPHREY. (L. Fitzgerald and E. J. Humphrey, United States.) September 2nd.

17,556. "Improvements in electro-magnetic apparatus." I. G. WATERMAN. September 2nd. (Complete.)

17,561. "Improvements in electro-magnetic spark extinguishing or arc preventing devices for electric switches." H. A. BERTRAM. September 2nd. (Complete.)

17,565. "Improved means for starting and working electrically actuated lifts with two cages." SIEMENS BROS. & Co., LIMITED. (Siemens & Halske Actiengesellschaft, Germany.) September 2nd. (Complete.)

17,567. "Improved combination of electric motors for starting and operating them." J. BURKE. September 2nd. (Complete.)

17,585. "Improvements in switches or cut-outs for trolley and other overhead electric wires." E. HOPPER. September 3rd.

17,593. "Improvements in electro-magnets." A. H. WEDDELL. September 3rd.

17,601. "Improvements in apparatus and devices for controlling electric currents." S. WATKINS. (The Consolidated Railway Electric Lighting and Equipment Company, United States.) September 3rd. (Complete.)

17,618. "Improvements in and relating to current-distributing and collecting devices for use in connection with electric railways, tramways and cranes, and for like purposes." J. T. KNOWLES. (E. A. Stierlin, Italy.) September 3rd.

17,621. "Improvements in or relating to apparatus for hauling electric cables." H. B. GRINNELL and P. GOEPEL. September 3rd.

17,611. "Improvements in dynamo-electric machinery." H. M. HOBART. September 3rd.

17,656. "Improvements in the manufacture of glass by electricity." C. G. REDFERN. (Société Anonyme de l'Industrie Verriere et ses Derives, Belgium.) September 3rd.

17,658. "Improvements in or relating to electric meters." F. SALDANA. September 3rd.

17,660 "Improvements in electric batteries." THE PILE-BLOC BATTERY COMPANY, LIMITED. (Date applied for under Patents, &c., Act, 1883, Section 103, August 30th, 1901, being date of application in France.) September 3rd.

17,664. "Improvements in or relating to electric transformers, exciter coils, field magnets, and other inductors." F. PICHLER. September 3rd.

17,673. "A trolley guide for the trolley poles of electric tramcars and similarly-propelled vehicles." C. MIDDLETON. September 4th.

17,676. "Improvements in automatic guards or protectors for electric or other tramway cars and the like." W. DEWAR. September 4th.

17,681. "Improvements in etheric or wireless telegraphy." A. MARR. September 4th.

17,702. "Improvements in the electrolytic refining of copper." THE METALS CORPORATION, LIMITED, and S. COWPER-COLES. September 4th.

17,703. "Improvements in the electrolytic production of tubes, sheets and wire." THE METALS CORPORATION, LIMITED, and S. COWPER-COLES. September 4th.

17,766. "Improvements in and connected with cut-outs." H. OPPENHEIMER. (Actiengesellschaft Mix & Genest.) September 5th.

17,801. "Improvements in transmitting telegraph keys." C. SHIRLEY and J. F. SKIRROW. (Date applied for under Patents, &c., Act, 1883, Section 103, February 6th, 1901, being date of application in United States.) September 5th.

17,811. "Electric clock." O. AXELEN-HOHN. September 5th. (Complete.)

17,860. "Improvements in electrical primers." SIR W. G. ARMSTRONG, WHITWORTH & Co., LIMITED, and G. STUART. September 6th.

17,877. "Improvements in and relating to trolley wire for electric tramways and the like." E. G. THOMAS. September 6th. (Complete.)

17,896. "Improvements in and relating to the production of copper, telegraphic, telephonic or cable wire from the copper rod." H. WALKER. September 7th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

24,439. "Improvements in systems of electric distribution, particularly applicable to electric railway systems." British Thomson-Houston Company. (General Electric Company.) Dated December 8th, 1899. Relates to arrangements for preventing earth currents in systems such as railway systems with a rail or like return conductor. Feeders are run to the trolley wires and also to the return conductor, and a motor-generator is arranged in connection with each pair of feeders and so designed that the whole of the return conductor is maintained at one potential. 1 claim.

24,450. "Improvements in electric telegraph apparatus." J. A. L. Dearlove and S. G. Brown. Dated December 8th, 1899. Automatic transmitting apparatus for submarine and other working. 3 claims.

24,451. "Improvements in storage batteries." H. H. Lake. (C. Bruno.) Dated December 8th, 1899. Relates to an electrode of extreme lightness and presenting a large contact surface, especially intended for use on motor road vehicles. It consists of an exceedingly thin conducting plate of lead or the like provided upon one or both sides with projections at right angles to its surface and produced by stamping. These projections enter the active material, which is applied in the form of sheets or plates. Each electrode is placed in a case or pocket of celluloid or the like, which is suspended within the general container by strap or loop-like prolongations of its upper portion which engage with transverse strips provided on the general container. 2 claims.

24,458. "Improvements in supporting electrical contact rubbers or brushes below rail or tramway vehicles." R. B. Ransford. (Compagnie Generale de Traction.) Dated December 8th, 1899. Relates to means for supporting collectors under vehicles mounted on two bogies. 1 claim.

24,514. "Improvements in or relating to electricity meters." A. J. Boult. (Saldana, F, 34 bis, Rue la Tour d'Auvergne, Paris.) Dated December 9th, 1899. An oscillatory motor meter has stationary main current field coils and a shaft carrying iron projections on a core which is magnetised in opposite directions alternately by two coils wound together and connected between the supply mains through a two-way switch. The core may be laminated for use with alternating currents, or replaced by coils. The oscillation of the shaft thus produced is retarded by one or more plates carried by it, moving between radial partitions in a cylindrical box containing air. 7 claims.

24,524. "Improvement in or connected with electric accumulators." G. Love and Monobloc Accumulator Syndicate. Dated December 9th, 1899. Relates to electrodes of the type described in Specification No. 21,966, A.D. 1896, in which the electrodes of one polarity consist of a number of rods or pencils which stand in apertures formed in a plate of opposite polarity. This invention consists in making the plate which has the apertures in it of a series of lead tapes which are laid the required distance apart, and upon them are laid another series of tapes at right angles to them so as to form the aperatures. The continuations of the first series of tapes are then turned back over the second series and then the second series are turned back over the first series and this is continued until the electrode is built up to the required height. 1 claim.

24,536. "Improvements in thermo-electric piles." L. Gottscho. Dated December 9th, 1899. Relates to thermo-electric batteries and consists, firstly, in enclosing the hot junctions in a chamber which may consist of sheet metal lined on both sides with asbestos; and, secondly, in connecting the hot junctions with the cold junctions by an intermediate conductor of reduced cross-section. This conductor may be of wire. 1 claim.

24,567. "Improvements in controlling apparatus for electric lifts and other electric machines." J. S. Stevens, C. G. Major, E. C. Stevens and P. H. Stevens. Dated December 11th, 1899. Relates to the controlling, &c., of continuous current motors for lifts, hoists, cranes, &c., and for other purposes, and consists of—(1) Apparatus for automatically cutting out resistances on starting, and putting them in on stopping or reversal; (2) multiple contact switch apparatus. 13 claims.

24,594. "Improvements in or connected with automatic electrical cut-outs." F. E. Groenstreet and E. J. Selby. Dated December 11th, 1899. The fusible wire is led through two hollow carbon rods which are pivoted and spring-controlled so that when the wire melts the arms swing apart and break the arc. The box is divided into two compartments by a partition on each side of which is fixed an insulating slab. Secured at the corners are terminals on which are pivoted holders for the hollow carbon rods. Springs or counterweights are also fitted on the terminals and tend to cause the arms to swing parallel to the sides of the box. The fusible wire is threaded through the rods and secured by binding screws. On the wire fusing the ends are drawn within the carbon tubes as they turn. 4 claims.

24,614. "Improvement in telephone system and apparatus." E. Ries. Dated December 11th, 1899. Relates to the arrangement of a combined telephone receiver and switch, and to central station apparatus for use therewith. 33 claims.

24,624. "Improvements in and relating to perforators for use in connection with automatic telegraph transmitters." W. Judd and G. Draper. Dated December 11th, 1899. Perforators for preparing telegraphic messages for submarine and other signalling are constructed with the perforating power obtained from a continuously-driven shaft, the elements of the combinations being obtained from three keys, or the combinations being produced by means of selecting mechanism operated by typewriter keys. The keys may be operated manually or by electro-magnets, in which case the instrument may be placed at the distant end of the line. When three keys are employed, two keys are for the signals, and one for spacing. 7 claims.

24,634. "Improvements in apparatus for electrically lighting railway carriages and other vehicles." C. A. Vicarino. Dated December 11th, 1899. The dynamo and battery are fixed to the underframe of the vehicle, and an automatic switch controls the supply. The dynamo is suspended by a hinged joint and driven by friction by means of a pulley keyed in one of the axles. The frame to which the dynamo is hinged is adjustably mounted on a rod. The field magnets of the dynamo have two windings. The current is maintained constant, though the direction of movement be reversed, by mounting the carbon brushes on a disc which is loose on the shaft. The disc is fitted with suitable contact rings which engage with contacts. The automatic switch comprises a double-wound solenoid having a hollow core, in the upper part of which is a cup containing mercury. Into this cup a fixed rod may dip. The core also carries a rod adapted to dip into a mercury cup. In modified arrangements a battery may be placed on each car and supplied from one dynamo. 5 claims.

24,643. "Improvements in magnet frames for dynamo-electric machines and motors." J. Burke. Dated December 11th, 1899. The poles are fitted on one or both sides with easily removable polar extensions which are secured in position by means of expansion devices inserted between two contiguous polar extensions or between one extension and a fixed abutment. The polar extensions are partially surrounded by the magnet coils, and serve to hold the latter in place. 2 claims.

24,645. "Automatic load starting apparatus applicable to synchronous alternating current motors." C. L. Rosenqvist A. Bergthell and H. W. Young. Dated December 11th, 1899. Relates to means for automatically connecting a synchronous alternating current motor with its load when it arrives at synchronism, and for automatically disconnecting it when synchronism is departed from or the motor is stopped. 3 claims.

24,716. "Improvements in telephone systems and apparatus." J. E. Kingsbury. Dated December 12th, 1899. Relates to telephone systems in which a central source of power is employed for both signalling and conversing. 16 claims.